Marine Engineering

MARCH, 1906

TRIAL PERFORMANCE OF UNITED STATES BATTLESHIP VIRGINIA.

By A. F. Bowen and H. B. Gregory.

General Description.

The *Virginia** is a twin screw, armored battleship, built by the Newport News Shipbuilding and Dry Dock Company. The contract was signed February 15, 1901, keel laid May 21, 1902, and the ship launched April 5, 1904. The launching weight was 5,983 tons, including 317 tons for cradle and shoring. The contract price was $3,590,000, of which $2,350,000 was allotted for the hull, and $1,240,000 for machinery. Armor, ordnance, anchors, chains, etc., supplied by the government, are not included in the above price. The contract time for the completion was thirty-six months, expiring February 15, 1904. This time was extended to December 27, 1905. The contract called for a speed of 19 knots on a mean draft of 23 feet 9 inches, and was to be maintained for four consecutive hours; the maximum air pressure finally allowed being 2¼ inches, and the average air pressure not to exceed 2 inches. The complement will be 49 officers and 772 men, making a total of 821 men in the crew.

*For description of this ship, with inboard profile, deck plans, several transverse sections, engine drawings and photographs showing her launching, see page 249, Marine Engineering, June, 1904.

THE BATTLESHIP VIRGINIA ON TRIAL TRIP.
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HULL DIMENSIONS.

Length between perpendiculars (also L. W. L.)	435 ft. 0 in.
" over all	441 ft. 3 in.
Beam molded	76 ft. 0½ in.
" extreme	76 ft. 2½ in.
Ratio of length to beam	5.70
Depth (molded)	41 ft. 3⅝ in.
Draught, normal, mean	23 ft. 9 in.
Displacement (mean load draft 23 ft. 9 in)	14,980 tons
Immersion per inch at L. W. L.	61.10 tons
Area of immersed midship section	1,734 sq. ft.
" " L. W. L.	25,640 sq. ft.
Wetted surface	39,150 sq. ft.

Center of gravity L. W. L. plane aft of M. S.	3.30 ft.
" " buoyancy above bottom of keel	13.0 ft.
" " buoyancy forward of M. S. (frame 54½)	0.11 ft.
Transverse metacenter above center of buoyancy	19 ft. 2½ in.
Longitudinal metacenter above center of buoyancy	519 ft. 0 in.
Coefficient of fineness, block	.686
" " " M. S.	.96
" " " L. W. L.	.775
Cylindrical (prismatic) coefficient	.7149
Number of frames	108
" " watertight compartments	324

ARMOR.

The armor consists of a side belt of Harveyized nickel steel, extending 2 feet 9⅝ inches above, and 5 feet 2⅞ inches below the 23-foot 9-inch load line. The thickness amidships is 11 inches at the top, and 8 inches at the armor shelf, tapering to 4 inches forward and aft. Above the armor belt is the lower casemate, of 6 inches; the upper casemate of 6 inches. The conning tower is 9 inches, and the signal tower 5 inches thick.

There are two elliptical superimposed 8 and 12-inch balanced turrets, forward and aft, revolving over circular barbettes. The turret armor is 12 inches on the face, and 6 and 8 inches thick on the vertical. The barbette armor for these turrets is 10 and 7½ inches thick. There are also two 8-inch elliptical broadside turrets, the front plates of which are 6½ inches thick, with the vertical sides 6 inches. The protective deck consists of two 30-pound plates, with an additional 60-pound plate on the slopes.

VENTILATION.

Fourteen systems are used for ventilating the ship, the majority of which supply air (plenum system) to the various compartments. Approximately 95,500 cubic feet of air is supplied per minute, and 6,990 cubic feet exhausted.

BATTERY.

The battery consists of the following principal guns: Four 12 and eight 8-inch breech-loading rifles, twelve 6-inch and twelve 3-inch rapid fire guns.

The torpedo plant is made up of four 21-inch submerged torpedoes, two forward and two aft, with corresponding compressors, accumulators, separators, etc.

EQUIPMENT.

There is a vertical Hyde steam anchor windlass on the main deck forward, the engine being located on the gun deck outside of the windlass house.

The steering engine is of the Williamson Bros. combined hand and steam type. The engine is controlled from the flying bridge, conning-tower and communicating room, by a wire rope actuating the engine-valve.

In the electric plant are six 50-kilowatt and two 100-kilowatt generating sets, all worked at a pressure of 150 pounds, and built by the Thresher Electric Company. The lighting output supplies approximately 1,134 incandescent 16-candle power lamps, 1,692 incandescent 5-candle power lamps for use in the battery control instruments, 6 arc lamps in the fire rooms, and 4 in the engine rooms. The dynamo engines are vertical cross compound. The 50-kilowatt engines have cylinders 8 and 16 inches in diameter, with a stroke of 8 inches. The 100-kilowatt engines have cylinders 10 and 20 inches in diameter, with a stroke of 10 inches. There are also six 30-inch search lights, two sets of night signalling apparatus, and various other electrical machinery.

The following boats will be carried, the handling of which will be done by four electrically operated cranes and boat davits: One 40-foot steam cutter, one 36-foot steam cutter, two 36-foot launches, four 30-foot cutters, two 20-foot dinghys, one 16-foot dinghy, or eleven in all.

PROPELLING MACHINERY.

There are two main engines of the four cylinder, vertical, inverted, direct-acting, triple expansion type, placed abreast in separate watertight compartments with a watertight door between.

The order of the cylinders is: Forward L. P., H. P., I. P. and after L. P. The H. P. and F. L. P. cranks are at 180 degrees, and the I. P. and A. L. P. cranks are at the same angle. The sequence of cranks is: H. P., I. P., F. L. P. and A. L. P. The engines are right and left, and turn the propellers inboard when going ahead. The designed power of the main engines is 19,000 indicated horsepower at about 120 revolutions per minute, wth a steam pressure of 250 pounds at the high-pressure valve chest.

The main engine cylinders consist of a cast iron casing embodying valve chests, steam ports and passages. All cylinders and valve chests are fitted with liners. The cylinder liners are secured to the cylinder casings at the bottom by countersunk screws. At the top there is a composition gland fitted for packing between the liner and the casing, and which allows for expansion, while making a tight joint. The space between the liner and the casing forms the steam jacket for the barrel of the cylinder. The cylinder covers are also jacketed. The valve chest liners are each in two parts—the upper and lower. They are forced into place and secured by screws tapped half into the liners, and half into the casings. The cylinder covers are of cast iron, strongly ribbed and fitted with central manhole. The valve chest covers are of cast iron, well ribbed, the upper covers embodying the balance piston cylinders, and the lower covers bored to receive the valve stem stuffing boxes.

The cylinders are supported on twelve forged nickel steel cylindrical columns, flanged top and bottom, for securing to cylinders and bed-plate, and having enlarged facings for the athwartship and longitudinal tie rods, braces and reverse shaft bearings. The columns are tied fore and aft by heavy cast steel I braces and forged steel diagonal rods, and strengthened athwartships by forged steel X frames with horizontal tie rods at the center. Additional stiffness is given the engines by athwartship tie rods between the cylinders, and fore and aft tie rods between the cylinders to special stiffeners on the forward and after engine room bulkheads.

The bedplates, of cast steel, are in three sections, each consisting of two longitudinal and two cross girders of I section, flanged for bolting together, and each section carrying two main bearings. They are secured to keelson plates provided in the hull structure.

All the main steam valves are of the single-ported piston type, with single cast iron packing rings and cast steel followers for the H. P., with forged steel for the I. P. and L. P. The H. P. valves are of cast iron; the I. P. and L. P. valves are built up with two heads of cast iron and a steel tube distance piece between. The H. P. cylinder has one valve; the I. P. and each L. P. cylinder two each. Each valve is provided with a balance piston fitted at the top of the valve stems, and working in a small cylinder in the valve chest covers, so designed as to relieve a part of the weight of the valve gear. The latter is of the Stephenson type with double-bar forged steel links; the H. P. valve stem being connected directly to its link block, while the two valve stems of each I. P. and L. P. cylinder are connected by a cross-head. The link blocks are of cast steel fitted with brass gibs. Each engine is handled by a steam reversing engine with oil controlling cylinder. They connect direct to arms on the reversing shaft, carried in bearings secured to the front of the engine columns, and provided with an arm for each link, fitted with adjustable cut-off block.

A 12-inch balance throttle valve is fitted to each engine, the balance being accomplished by a piston working in a cylinder cast in valve casing. The valve is controlled by a large handwheel at the working platform.

The pistons are conical in shape, the H. P. being of cast iron

and the I. P. and L. P. of cast steel. All the pistons are fitted with forged steel followers, secured to the piston bodies by studs and nuts having square shoulders, where they pass through the followers to prevent turning. The H. P. and the I. P. pistons are fitted with one solid packing ring set out by steel springs. The L. P. piston packing consists in two rings of seven sections each, set out by steel springs.

The piston rods are hollow, of high grade nickel steel, oil-tempered and annealed. They are accurately ground cylindrical and polished, tapered at each end to fit the piston and crosshead. The crosshead is of nickel steel, forged with the crosshead pins, and is bolted to the cast steel slipper, which is lined with white metal on the sliding faces.

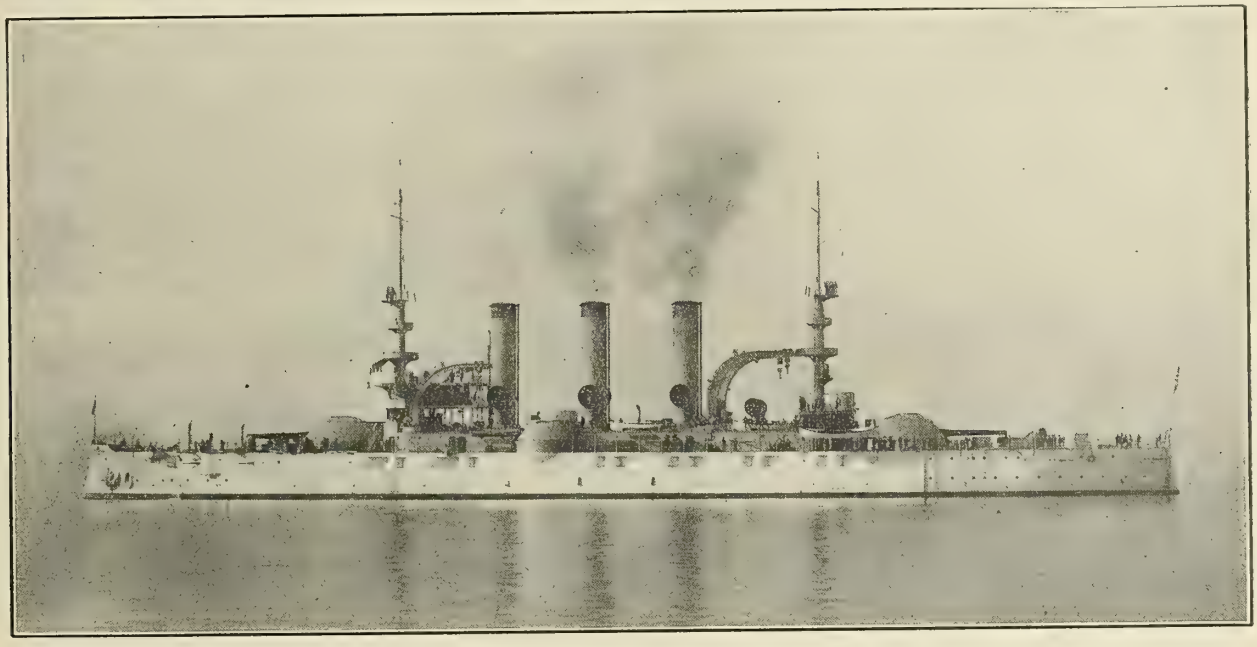
The go-ahead crosshead guides are of cast iron, hollow for water circulation, and are bolted to lugs on the cylinders at the top, and to the cast steel I brace of the engine framing at the bottom. The backing guides are of cast steel, and are bolted to flanges on the ahead guides.

The connecting rods are of the same material as the piston rods with axial hole, and are forked at the upper end to carry the crosshead brasses. To the lower end are secured the crank-pin brasses.

The eccentrics are in two parts, secured together by two screw tap bolts, the larger part of cast iron and the smaller of wrought steel. The backing eccentrics are securely keyed to the crank shaft, and the go-ahead eccentrics secured to them by a bolt fitted in an elliptical hole to allow for adjusting same. The eccentric straps are of composition, lined with white metal. To the upper part of the straps are secured the eccentric rods, which are of nickel steel. The upper ends of the rods are forked to span the main links at the link pins, adjustable brasses being fitted for these pins.

All shafting is of hollow forged nickel steel. The crank and line shafts are each in two sections, and the thrust, stern tube and propeller shafts are one section each, for each main engine. A worm wheel for turning the main engines, and operated by a turning engine, is fitted over the coupling flanges between the two sections of the crank shaft, one for each engine. There are six main bearings for each complete crank shaft, two steady bearings for each thrust shaft, one spring bearing for each line shaft, two stern tube bearings for each stern tube shaft, and one strut bearing for each propeller shaft. At the forward end of each stern tube is fitted a stuffing box and gland for making a watertight joint with the shafting. Wherever the shafting pierces a watertight bulkhead, a shallow stuffing box is fitted to preserve watertightness.

All shaft couplings are of the flange type forged to the shafts, except for the inboard coupling of the stern tube shaft and the outboard coupling securing stern tube and propeller shafts. The former consists of a forged steel collar secured on the end of the shaft by four steel keys; behind this collar is another collar in halves, and fitting snugly around the shaft behind the shoulders of the collar seating, both collars being bolted to the after flange of the line shaft. The outboard coupling consists of a forged steel sleeve, taper bored from ends to center for the reception of tapered shaft ends. It is secured from turning by two steel keys at each end, and the shafts are secured against withdrawal by tapered cotters driven through slots in sleeve and shaft ends, the grooves around cotter slots being filled with solder, and screw stop pins let in to secure the cotters. The sleeve couplings are covered by a cast composition casing, the space between the casing and couplings being filled with tallow and resin melted together.



THE UNITED STATES BATTLESHIP VIRGINIA.
(Upper 8-inch Turrets not yet fitted.)

The thrust bearings, one for each engine, are of the ordinary horseshoe type, consisting of a cast iron pedestal bolted down on a cast iron sole plate. The latter is securely fastened by rivets to the foundation built up from the hull structure. The lower part of the pedestal forms an oil trough in which the lower part of the collar seating, both collars being through bolted to the circulating coil for cooling the oil. A steady bearing is at either end of the pedestal. There are twelve horseshoes of cast steel, made hollow for the circulation of water, and lined with white metal on both sides, except that the forward one is lined only on the after side, as it is only for forward thrust, and bears on the forward side of the forward collar. Each horseshoe is independently adjusted fore and aft by steel screwed side rods and wrought iron clamp nuts.

ENGINE DATA.

Cylinders, H. P., diameter, inches	35
I. P., diameter, inches	57
L. P. (2), diameter, inches	66
Stroke of all pistons, inches	48
Piston valves, H. P. (1 each cylinder), diameter, inches	20
I. P. (2 each cylinder), diameter, inches	22
L. P. (2 each cylinder), diameter, inches	25

Number of Run	Which Engine	Steam Pressures Pounds Per Square Inch: Boilers (Gauge)	At Eng. (Gauge)	H. P. Steam Chest (Absolute)	1st Rec. (Absolute)	2d Rec. (Absolute)	Mean Effective Pressures Pounds Per Square Inch: H. P. Cyl.	I. P. Cyl.	F. L. P. Cyl.	A. L. P. Cyl.	Referred to L. P. Cyls.	Vacuum in Inches	Air Press. in Fire Room in Inches of Water
1-S	S	262	250	255	105	35	109.7	46.5	15.9	18	49.38	27	.92
	P		245	255	100	34	107	49	16.2	17.6	49.89	27.2	
2-N	S	268	255	260	105	35	121	47	16.1	19	51.72	27.3	1.21
	P		250	260	102	36.5	106.5	51.5	18	18	52.29	27	
3-S	S	263	245	255	105	36	110	48	16.5	18.4	50.47	27.2	.93
	P		240	250	119	37	92	57	18.2	17.5	51.74	27	
4-N	S	263	245	255	120	40	101.5	56.5	18	20	54.02	27.3	1.27
	P		245	255	103	36.8	101.5	52	18.1	17.5	51.13	26.6	
5-S	S	264	250	255	115	38	99.5	56.5	18.2	20.2	53.94	27.4	1.11
	P		245	255	117	36	99.5	53.5	17.6	18.6	51.72	27.2	
6-N	S	266	250	260	90	32	126.5	40.5	12.7	14.1	45.92	26.1	1.11
	P		245	255	99	31	120	45.5	13.5	14.5	47.47	27.4	
7-S	S	259	245	235	81	28	119	38.3	13.2	15.8	45.16	28.3	.47
	P		245	241	84	26	110	39	11.2	13.3	41.93	27.5	
8-N	S	260	247	215	70	24	109	32.5	11	13.6	39.42	28.5	.49
	P		247	205	78	24	104	36	12.9	12.2	40.28	28	
9-S	S	257	250	205	65	20	92	31	9.2	12.7	35.17	28	.18
	P		252	190	70	21	98.5	33.1	12.3	10.8	37.94	28.5	
10-N	S	244	225	190	62	19	98.5	29.1	8.8	11.8	34.71	27.2	.19
	P		226	175	64	19.5	94	29.2	9.8	9.9	33.67	28.3	
11-S	S	253	240	180	57	20	93	26.8	9	10.1	32.35	28	.15
	P		242	168	61	19.2	89	29	9.5	9.4	32.25	27.7	
12-N	S	248	238	165	52	18.5	86	35	8.3	9	33.53	28	.32
	P		237	162	58	17.2	84	27.1	8.3	8.4	30 01	27.6	

Main steam pipe, diameter at throttle, inches..... 12
Net area of I. P. to H. P. piston, ratio.....2.652 to 1
L. P. pistons (2) to H. P. piston, ratio...7.112 to 1
Piston rods, diameter, inches 8
axial hole, H. P. and I. P., inches.. 4
L. P., inches.. 5
length, feet and inches..... 9— 4⅛
Connecting rod, length center to center, inches..... 96
diameter upper end, inches..... 7¾
diameter lower end, inches..... 9
diameter axial hole, inches..... 5
Crank shafts, diameter, inches 17½
diameter axial hole, inches..... 10¼
diameter coupling disc, inches..... 32
thickness coupling disc, inches..... 3¾
coupling bolts (8 each flange), diameter, inches 3½
length forward section H. P. and F. L. P., feet and inches.....15— 6¼
length after section, I. P. and A. L. P., feet and inches.....16—10
Crank pin, diameter, inches 18
length, inches 21½
axial hole, diameter, inches..... 10½
Crank webs, width, inches 20
thickness, inches 11
Thrust shaft, diameter, inches 16½
axial hole, inches..... 10¼
length, feet and inches.....13— 7½
collars, number on each shaft..... 12
diameter, inches 27
thickness, inches 2
space between, inches..... 4
Line shafts, diameter, inches 16½
axial hole, inches..... 10¼
length forward section, feet and inches....14—11½
after section, feet and inches.....14—11
Stern tube shaft, diameter, inches 17½
diameter axial hole, inches..... 10¼
length, feet and inches.....36— 0
Propeller shaft, diameter, inches 17½
diameter axial hole, inches..... 10¼
length, feet and inches.....25— 8¼
Reversing engine, diameter steam cylinder, inches..... 16
diameter oil cylinder, inches..... 8
stroke, inches 22
Turning engine, diameter steam cylinders (2), inches..... 7
stroke, inches 5

AUXILIARY MACHINERY.

Main Condensers.—There is one main condenser for each main engine. They are cylindrical in form, with steel shell and composition water heads.

Diameter of shell (inside)..... 7 feet 0 inches
Length over all.....15 feet 5 inches
Tubes, diameter (outside) ..... ⅝ inch
length between tube sheets.....12 feet 10 inches
thickness, No. 18 B. W. G..... .049 inch
number in each condenser..... 5,684
Cooling surface, square feet, each..... 11,969

Main Air Pumps.—There are two main air pumps, one in each engine room, of the Blake, twin cylinder, vertical, beam, single acting type.

Diameter steam cylinders (2).....14 inches
Diameter pump cylinders (2).....32 inches
Stroke .....21 inches

Main Circulating Pumps.—One centrifugal, double-inlet, circulating pump driven by a compound engine is provided for each main condenser. Each pump has a capacity of 12,000 gallons of water per minute at about 266 revolutions. Each pump is arranged to draw from the sea, the main drain and the engine room bilge, and discharges through the condenser, or directly overboard, through the by-pass in the inlet and outlet condenser head, to the overboard delivery. The suction valves to these pumps are so interlocked that the sea valve and the bilge and drain valve cannot be opened at the same time.

Diameter of steam cylinders...H. P. 11 inches, L. P. 22 inches
Stroke .....10 inches
Diameter of pump runner.....45 inches
" " inlet nozzles (2).....15½ inches
" " outlet " .....20 inches

Number of Run	Time on Course Min.-Sec.	Which Engine	Revolutions Main Engines: To Make One Knot	Per Min.	Mean Per Min.	Speed in Knots	Indicated Horsepower: Main Engines: H. P. Cyl.	I. P. Cyl.	F. L. P. Cyl.	A. L. P. Cyl.	Total	Total Both Engs.	Total Aux. in Operation During Test	Total All Machinery
1-S	3-2.5	S P	390.6 389.45	128.45 128.07	128.26	19 731	3200 3112	3658.5 3844	1681.5 1708	1903.5 1856	10443.5 10520	20963.5	704.2	21797.3
2-N	3-18.4	S P	424.30 424.95	128.38 128.57	128.47	18.152	3527.8 3109.6	3695.8 4055.6	1701.7 1905.3	2008.2 1905.3	10933.5 10975.8	21909.3	709.0	22727.6
3-S	3-2.4	S P	393.55 394.15	129 49 129.69	129.59	19.742	3234.9 2908.9	3807 4527.8	1759 1943.3	1961.6 1868.5	10762.5 11049.3	21811.8	720.9	22636.7
4-N	3-16.6	S P	426.20 420.05	130.07 128.19	129.13	18.311	2998.3 2954.9	4501.3 4082.9	1927.5 1910.3	2141.8 1846.9	11568.9 10795	22363.9	677.7	23147.2
5-S	3-2.8	S P	398.40 394.75	130.91 129.71	130.31	19.694	2958 2930.9	4530.3 4250.4	1961.6 1879.5	2177.1 1986.3	11627 11047.1	22674.1	689.9	23459.4
6-N	3-18.4	S P	414.35 414.45	125.18 125.21	125.20	18.145	3596.2 3412.2	3105.3 3489.4	1308.8 1391.6	1453.1 1484.8	9463.4 9788	19251.4	564.6	19911.4
7-S	3 11.9	S P	383.55 381.15	119.96 119.20	119.58	18.760	3242.0 2977.8	2814.2 2847.4	1303.7 1099.1	1560.5 1305.2	8920.4 8229.5	17149.9	387.8	17633.1
8-N	3-27.8	S P	396.90 397.35	114.63 114.76	114.70	17.329	2844 2710.4	2281.8 2530.4	1038.1 1218.8	1283.5 1152.7	7447.4 7612.3	15059.7	358.6	15513.7
9-S	3-21.6	S P	376.95 376.80	112.30 112.25	112.28	17.857	2346.4 2510.9	2132.3 2275.7	850.6 1136.7	1174.2 998.1	6503.5 6921.4	13424.9	329.7	13849.6
10-N	3-38.1	S P	398.45 394.55	109.62 108.54	109.08	16.506	2452.2 2317.0	1953.8 1941.2	794.2 875.7	1065 884.7	6265.2 6018.6	12283.8	290.8	12669.1
11-S	3-31	S P	377.15 375.85	107.30 106.93	107.12	17.062	2266.2 2161.2	1761.3 1899.3	795 792.3	892.2 827.5	5714.7 5680.3	11395	288.6	11785
12-N	3-47	S P	386.00 388.45	102.05 102.70	102.38	15.863	1947.7 1859.2	2187.7 1704.7	697.4 701.8	756.1 710.2	5588.9 5075.9	10664.8	294.7	11069.5

Feed and Filter Tanks.—There is located in each engine room, under the main condenser, one combined feed and filter tank, of 4,800 gallons capacity. The filter box is built in the upper after end of the tank. It consists of three separate compartments, each filled with the filtering material through which the water from the main and auxiliary air pumps' discharge passes successively before entering the feed tank.

Feed Pumps.—There are four main feed pumps of the Blake simplex, vertical, double-acting, center-packed plunger type, located on the forward bulkheads, two in each engine room. They are arranged to draw water from the feed tanks direct or from the hot well pump discharge, through the feed water heaters, and discharge into the main feed line only. There are six auxiliary feed pumps of the same type as the above, located one in each fire room on the centerline bulkhead. They have suction from the feed tanks, the sea, the boiler blow pipes and the drainage manifold in their own compartment, and discharge into the auxiliary feed line, overboard, and the fire main.

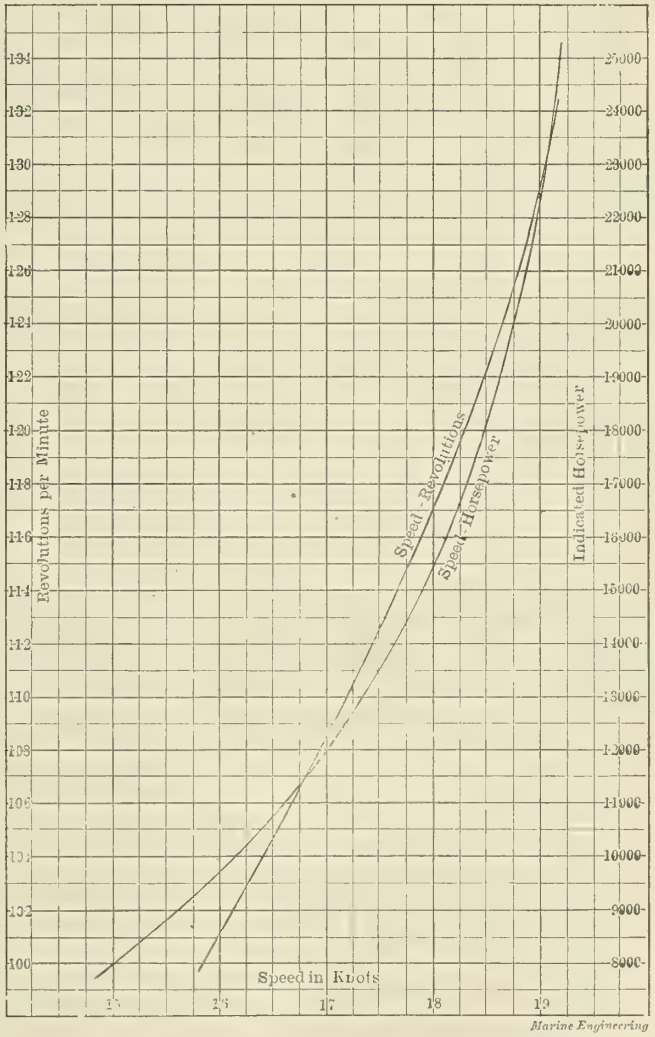
Main feed pumps, diameter of steam cylinder .....14 inches
" " water " .....10 inches
stroke .....12 inches
Auxiliary feed pumps, diameter of steam cylinder.....11 inches
" " water " ..... 8 inches
stroke .....12 inches

Hotwell Pumps.—There is one Blake simplex, vertical, double-acting, hotwell pump in each engine room, having suction connections to the feed tanks, reserve feed tanks in the double bottoms, and the filling pipe from side of ship. These pumps discharge through the feed water heaters to the main feed pumps' suction, to the feed tank, and to the reserve feed tank.

Diameter of steam cylinder .....12 inches
" " water " .....14 inches
Stroke .....12 inches

Distiller Circulating Pump.—There is one distiller circulating pump in the starboard engine room, of the same size and type as the hotwell pumps. This pump has a sea suction and discharges overboard, or to the flushing main through the distillers or direct.

Fire and Bilge Pumps.—There is one fire and bilge pump of the Blake simplex, vertical, double-acting type, located in each engine room. These pumps draw water from the sea, the



SPEED CURVES BASED ON HORSEPOWER AND REVOLUTIONS.

drainage system and from the bilges in their own compartment, and discharge into the fire main or ovrboard.

Diameter of steam cylinder ..... 12 inches
" " water " ..... 10 inches
Stroke ..... 12 inches

Feed Water Heaters.—There is one horizontal feed water heater in each engine room, located high up under the protective deck. The heating agency is exhaust steam from the auxiliary exhaust line which enters the shell at the top, circulates around the tubes and then drains at the bottom. The feed water passes through the tubes. A spring relief valve is provided at the exhaust inlet to adjust the back pressure for properly heating the feed water.

Diameter of shell (inside) ..... 2 feet 11½ inches
Tubes, number 852
diameter, outside ..... ⅝ inch
thickness, No. 16 B. W. G. ..... .065 inch
length between tube sheets ..... 6 feet 10 inches
length over all ..... 8 feet 8¾ inches
Heating surface, square feet, each 950

Auxiliary Condensers.—There are three auxiliary condensers, one in each engine room, and one in the lower dynamo room on the port side outboard. They are of the Wheeler type, with combined air and circulating pump attached to and under the condenser.

	ENGINE ROOM	DYNAMO ROOM
Diameter of shell (inside)	2 feet 4 inches	2 feet 11¼ inches
Length over all	7 feet 10¾ inches	9 feet 1½ inches
Tubes, number	552	1001
diameter, outside	⅝ inch	⅝ inch
thickness, No. 18 B. W. G.	.049 inch	.049 inch
length between tube sheets	6 feet 8 inches	7 feet 4 inches
Cooling surface, square feet, each	601.4	1200.9

Forced Draft Blowers.—There are twelve Sturtevant blowers, situated two in each boiler compartment above the boilers. They deliver air directly into the fire rooms, the closed fire room system being used. Type of blower engines—two cylinder, vertical, double engine.

Steam cylinders, diameter ..... 6 inches
Stroke ..... 5 inches
Fan, diameter ..... 66 inches

Ash Hoists.—For the removal of ashes from the fire rooms, one ventilator in each fire room is fitted with angle guide strips to facilitate the hoisting of buckets through same and thence by trolley to chutes at the ship's side. The hoisting is done by three Williamson Bros., 4½x4½ inches, reversible ash hoist engines, one located at the gun deck level immediately above each pair of athwartship fire rooms.

Distilling Apparatus.—The distilling apparatus is situated on the berth deck just forward of the engine hatch. It consists of four evaporators of the horizontal type, and three vertical distillers located in a trunk above the evaporators. The designed capacity of the plant was 19,000 gallons of water per twenty-four hours, which requirement was most successfully met when tested.

Refrigerating Apparatus.—This plant consists of one three-ton Allen dense air ice machine of the latest design, supplying air to the cold storage rooms, ice-making tank, and scuttle butts. The official test of this plant showed highly satisfactory results.

SCREW PROPELLERS.

The screw propellers are three-bladed, of manganese bronze, and turn inboard when going ahead. They are designed as true screws, and the surfaces of the blades are ground smooth with an emery wheel, and edges filed sharp. The hubs and blades are cast separate, the latter being bolted to the hub by nine tap bolts each; and the bolt holes in the palms of the blades are elliptical to permit of adjusting the pitch. When the pitch has been set, the space between the bolts and edges of the elliptical holes is filled in with fitted composition chocks to prevent the blades from turning and altering the pitch.

Diameter of propeller ..... 17 feet 3 inches
" " hub ..... 4 feet 6 inches
Pitch as set ..... 18 feet 7 $\frac{3}{16}$ inches
Helicoidal area, square feet 84.5
Disk area, square feet 233.71
Pitch ÷ diameter (pitch ratio) 1.078

BOILERS.

There are twenty-four Niclausse boilers arranged in groups of four in six boiler compartments. Each group consists of two pairs of boilers with athwartship fire rooms between pairs. In general the boilers consist of a number of elements, each composed of a vertical header and tubes connected to same. The headers are arranged side by side across the front of the boiler, with the tubes inclined slightly downward, and extending to the rear over the grates. A horizontal drum surmounts the headers to which they connect. The twelve inboard boilers are composed each of sixteen elements, and the twelve outboard boilers of fifteen elements.

Floor space, length, each boiler ..... 8 feet 7 inches
width (15-element boiler) ..... 9 feet 10 inches
width (16-element boiler) ..... 10 feet 5¼ inches
Grates, length ..... 6 feet 8⅝ inches
width (15-element boiler) ..... 8 feet 9 inches
width (16-element boiler) ..... 9 feet 4¼ inches
surface (15-element boiler) ..... 58.78 square feet
surface (16-element boiler) ..... 62.86 square feet
surface (all boilers) ..... 1,459.68 square feet
Heating surface, (15-element boiler) ..... 2,320.07 square feet
(16 element boiler) ..... 2,474.44 square feet
(all boilers) ..... 57,534.12 square feet
Ratio H. S. ÷ G. S. 39.41
Number of generating tubes in one boiler (15-element) 360
Number of generating tubes in one boiler (16-element) 384
Diameter generating tubes ..... 3¼ inches
Thickness generating tubes (No. 6 B. W. G.) ..... 0.203 inch
Diameter circulating tubes ..... 1 $^{19}/_{32}$ inches
Thickness circulating tubes (No. 21 B. W. G.) ..... 0.032 inch
Diameter steam drum, inside ..... 40½ inches
Working pressure, designed, pounds per square inch 265

STANDARDIZATION TRIAL.

The *Virginia* sailed from Newport News, Va., on Saturday morning, November 18, 1905, and proceeded to Rockland, Me., the place designated for the trials. On the run up the coast, the engines were thoroughly tested by the builders. Rockland was reached Monday morning, November 20, after a most successful trip, and immediately after coming to anchor preparations for the trials began.

The method of trial decided upon was that generally known as the standardization method. It consists of progressive runs over a measured mile, and from the data taken thereon, curves are plotted from which the speed of the vessel may be readily obtained for any number of revolutions of the main engines. The progressive trials were run over the government course at Rockland, on Tuesday, November 21. Twelve progressive runs were made, and the results obtained are shown in Tables I and II. The curves are plotted from this data.

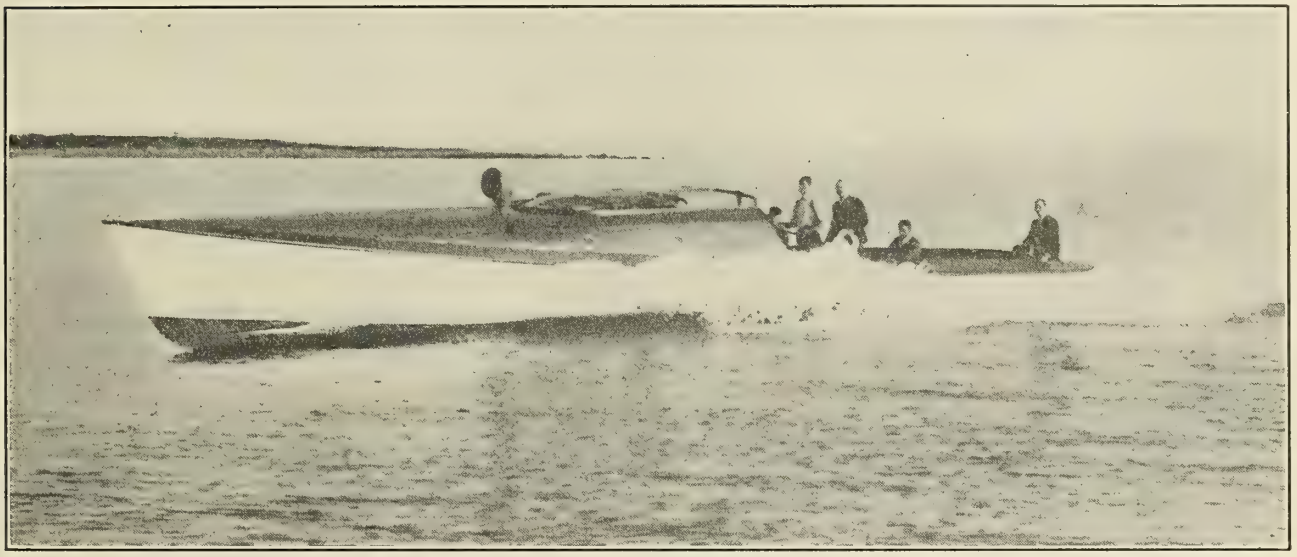
From the data obtained, 129.4 revolutions per minute of the main engines was found to be necessary to make the contract speed of 19 knots.

FOUR HOURS' TRIAL.

This trial took place on Thursday, November 23, at sea, between Rockland and Boston, and an average speed of 19.01 knots was maintained for the four hours.

The following is the data obtained:

	Starb'd		Port.
Steam pressure at boilers (gauge),		260	
engine room (gauge),	240.5		250.8
H. P. steam chest (gauge),	227.4		229.6
1st Receiver (absolute),	114.2		122.
2d Receiver (absolute),	38.8		39.6
Vacuum in condensers, inches of mercury,	27.2		27.
Revolutions per minute:			
main engines (mean trial),	129.6		129.54
average for both,		129.57	
circulating pump,	169.7		167.
blower engines, average,		528	
dynamo engine,		80	
Total, auxiliary machinery,		967.25	
Total, all machinery in operation during trial,		23,468.45	
Coal, kind and quality,		New River, hand picked	
pounds per hour,		68,507	
pounds per square foot of G. S.,		46.932	
pounds per square foot of H. S.,		1.191	
pounds per I. H. P. per hour of all machinery in operation during trial,		2.877	
I. H. P. (total) per square foot of G. S.,		16.078	
I. H. P. (total) per square foot of H. S.,		.408	



VERITAS AT FULL SPEED ON THE HUDSON RIVER.

Double strokes of main air pumps,	19.8		22.3
main feed pump,	26.6		35.7
fire and bilge pump,	68.2		73.6
hotwell pump,	35.8		32.
Speed of ship, in knots,		19.01	
Slip of propellers, in percent of their own speed, based on mean pitch and average speed,	20.07		20.04
Air pressure in fire rooms, inches of water,		1.78	
Mean effective pressures main engines:			
H. P. cylinder,	97.3		82.31
I. P. cylinder,	54.1		58.46
F. L. P. cylinder,	17.7		20.06
A. L. P. cylinder,	19.8		20.01
Mean equivalent pressure in pounds per square inch referred to combined area of L. P. pistons,	52.32		53.15
Indicated horsepower main engines:			
H. P. cylinder,	2,863.8		2,421.5
I. P. cylinder,	4,296.3		4,640.7
F. L. P. cylinder,	1,887.2		2,139.6
A. L. P. cylinder,	2,117.9		2,134.2
Total,	11,165.2		11,336.
Total, both main engines,		22,501.2	
main air pump,	11.75		13.3
main circulating pump,	56		53.
main feed pump,	69.5		102.
fire and bilge pump,	7.8		4.7
hotwell pump,	18.5		15.9
sanitary pump,		6.8	
blower engines,		528	

PROBLEMS IN CONNECTION WITH HIGH SPEED LAUNCHES.*

BY CLINTON H. CRANE.

The very recent development of the so-called "gasoline engine," of extremely light weight in proportion to its power, has given the opportunity of making another step forward in the direction of great speed upon the water. Up to the present time gasoline engines of extremely light weight have been available only in powers up to 300 horsepower, and in the majority of cases of successful operation, in powers not exceeding 150 horsepower. In utilizing this new form of power up to the present time the size of the boats has necessarily been small. In choosing a type of hull naval architects have had to avail themselves of what had already been done in steam.

A glance at the four torpedo boats illustrated will show the very great differences in the shapes of waterlines, profiles and sections adopted by these four successful designers, to produce an easily-driven hull. Such differences would seem to show that, with a given displacement and power, the shape of the under-water form, provided it be reasonably fair, was not of the greatest moment, or rather, that there might be objections to the more easily driven form which made some compromise advisable.

This statement must be modified, as I do not wish to be understood that the services of a skilled naval architect are unnecessary in the building of the fastest possible launch. The saving of weight to the last ounce is a matter of great engineering skill. The choice of a proper propeller, the adaptation of a form which can maintain its speed in rough as well as smooth water

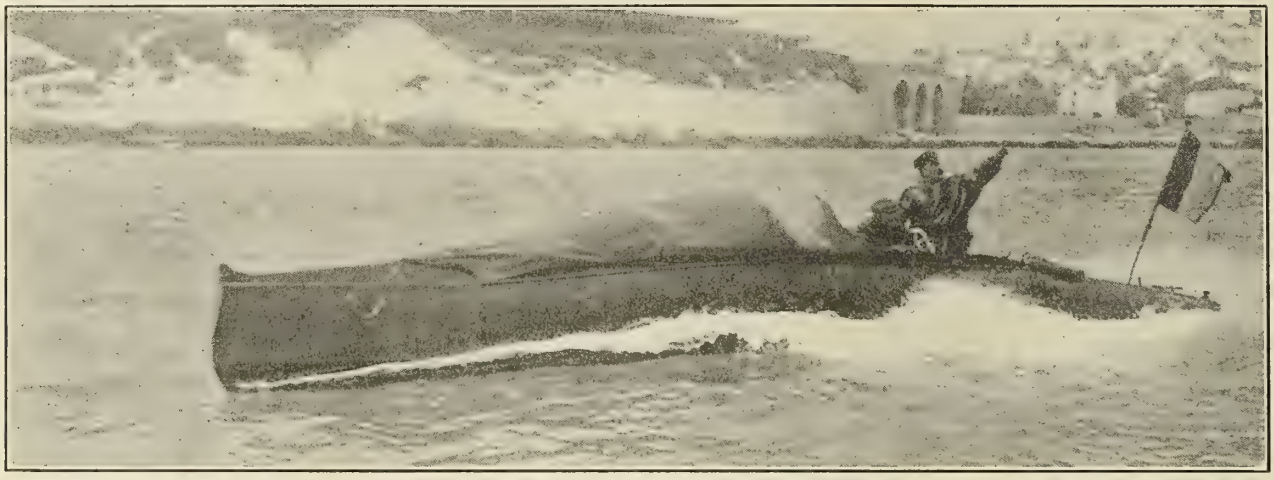
*Read at the thirteenth general meeting of the Society of Naval Architects and Marine Engineers, November 17, 1905.

—all these are matters calling for the greatest possible training, experience and attention.

The simile of the skipping stone has been used by a number of engineers in describing the action of these light, high-speed vessels. The idea that a boat should skim over the top of the water and not go through it is by no means a new one. Over thirty years ago a clergyman, the Rev. C. Ramus, was so firmly convinced that all vessels should proceed in this manner that

3 tons 4 cwt.

This gives us a very interesting comparison with the *Dixie,* which was driven by a single engine of 8 cylinders of the same diameter and slightly greater stroke. It may be reasonably assumed that the powers developed in the two boats are practically the same. The speed attained by the *Dixie* was practically the same, although her displacement is nearly 2,000 pounds less than that of the Yarrow boat.



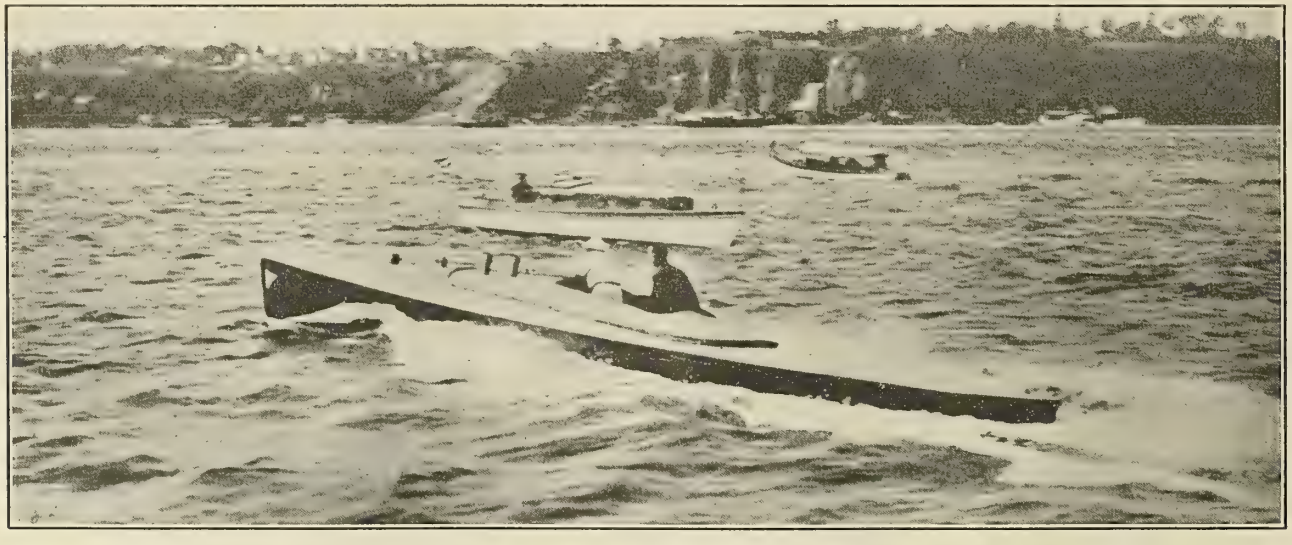
TREFLE á QUATRE IN THE RACES AT MONACO.

ne succeeded in prevailing on the English Admiralty to give his ideas a trial in the experimental tank at Torquay. The result of these trials seemed to show the absolute fallacy of the reverend gentleman's ideas; but the experiments were based on what was then possible in the direction of displacement and power, and with what then seemed a most liberal prediction of future possibilities. We can only feel that Mr. Ramus lived too early.

Two years ago Mr. Yarrow conducted a number of experiments with full size models in a 40-ft. launch towed by one of his 25-knot torpedo boats. The model which gave the least

This seems to confirm Mr. Yarrow's conclusion that in boats of this size and going at this speed the skimming idea gives the lesser resistance. It is, however, associated with the form of hull, which is very badly adapted to maintaining high speed in a seaway. As a matter of fact, in spite of her extra weight of hull, *Napier II* was obliged to withdraw from a number of her races, owing to leaks caused by the pounding of her flat bottom on the waves.

I think no one will question the fact that sharp ends and sharp floors go through a sea with far less shock and trouble than



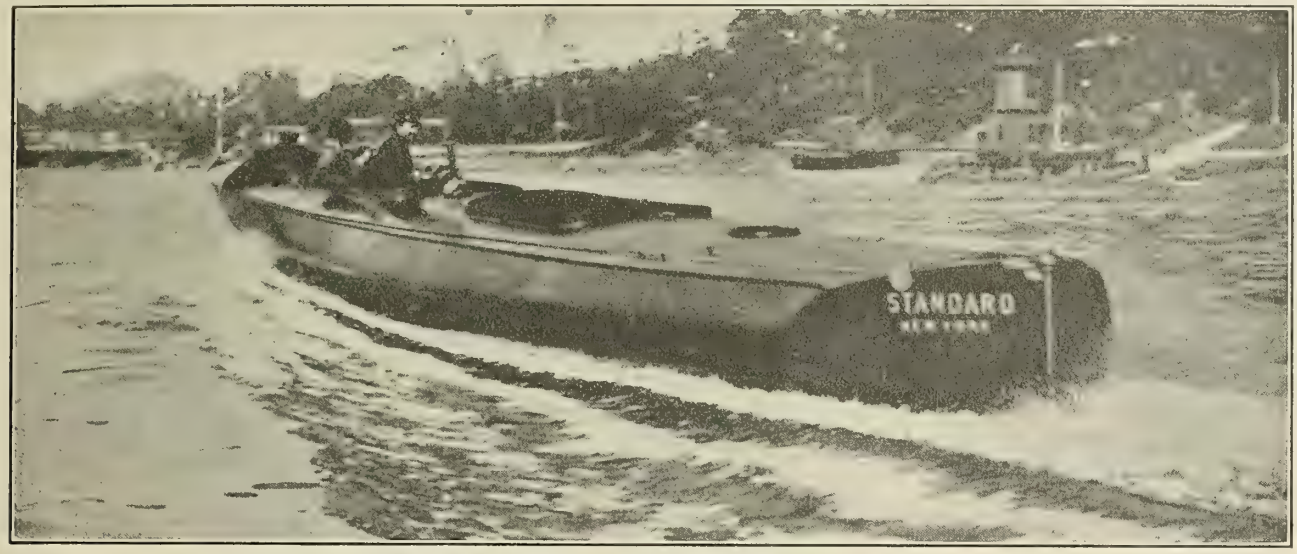
XPDNC OPPOSITE THE WEEHAWKEN PALISADES.

resistance at this speed was a flat bottomed scow, which appeared to glide along the surface of the water. Based on this experiment the *Napier II* was designed with such modification of bow as seemed essential for a boat which would be called upon to perform in a seaway. The final successful trial of this boat was made in March of 1904, on the Thames, at Greenwich, and a speed of practically 26 knots was attained. The boat was driven by two four-cylinder Napier engines, and the displacement on trial was

extremely full ends and flat floors. It is not so much that the flat floors stop a boat's progress as that they put a shock and jar on the whole fabric, which necessitates heavier construction and does away with the possible advantages gained by this particular form of hull.

The most serious objection to sharp bows and "tooth-pick" sterns, as they used to be called, is the loss of stability which this form involves. Apparently this loss of stability is much more

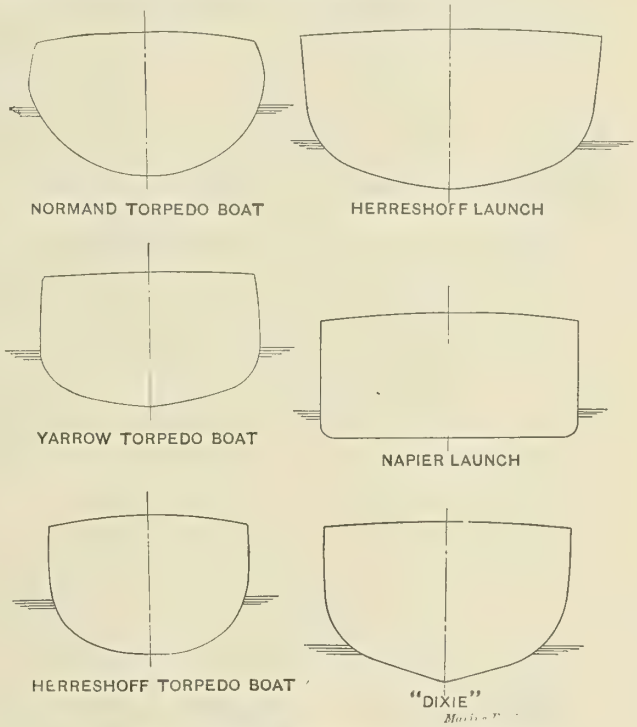
serious and more noticeable at high speeds than at low. Whether this is entirely due to the increased torque of the propeller, is a matter about which the writer is not yet entirely clear. This torque of the propeller in a fast single screw launch is a matter of serious consequence. In the case of the *Dixie*, running at full power, this torque amounts to placing a weight of 350 pounds at the gunwale, or about 8 percent of the boat's weight. This can, of course, be partially compensated for by placing the machinery off the center.



STANDARD RUNNING AT HIGH SPEED.

Launches.	Torpedo Boats.	Designer.	L'ength of W. L.	Disp. in L'bs. or Tons in Running Condition with Crew and Fuel on Board.	Horsepower.	Cylinders. Number.	Cylinders. Diameter.	Cylinders. Stroke.	Maker of Engine.	Speed in Knots.	Weight in L'bs. per H. P.	Weight Reduced to 40 Ft. W. L.	Corresponding Speed in Knots 40 Ft. W. L.
XPDNC.....	.....	Herreshoff.	42.2	3,250 lbs.	75	4	6¼	5¾	Mercedes.	23	43.4	2,750	22.4
Napier.....	.....	Yarrow	40	7,170 lbs.	150	8	6¼	6	Napier ...	25.98	47.8	7,170	25.98
(Twin screw.)													
Dixie.....	.....	Crane.....	40	5,160 lbs.	150	8	6⅛	6¾	Smith & Mabley.	26	34.4	5 160	26
Veritas	.....	Gielow	56	12,000 lbs.	283	8	7¾	9	Craig.....	23.2	42.4	4.370	19.6
Panhard....	.....	Electric Launch Co.	39.91	3,621 lbs.	70	4	6 15/16	6.68	Panhard..	23	51.7	3,621	23
Vingt-et-Un II	.....	Crane	38.75	3,850 lbs.	75	4	6¼	6¼	Smith & Mabley.	22	51.4	4 225	22.35
.....	Normand torpedo boat.	.....	157	168 tons.	3,920	..	..	..	....	29.15	96	6,250	14.7
.....	Yarrow torpedo boat.	.....	152.7	144 tons.	2,000	..	..	..	....	25	161.5	5 800	12.8
.....	Herreshoff torpedo boat.	.....	175.5	165 tons.	3,200	..	..	..	....	28.6	115.5	4.380	13.65
.....	Thornycroft torpedo boat destroyer.	.....	244	420 tons.	8,000		..	..	....	29	117.5	4.160	11.75

Unfortunately, however, for the comfort of those on board this torque is by no means a constant quantity. If the boat throws her wheel out of water. even to a small extent, in the hollow of a wave, this torque is suddenly relieved and the recoil in the opposite direction is sudden and disconcerting.



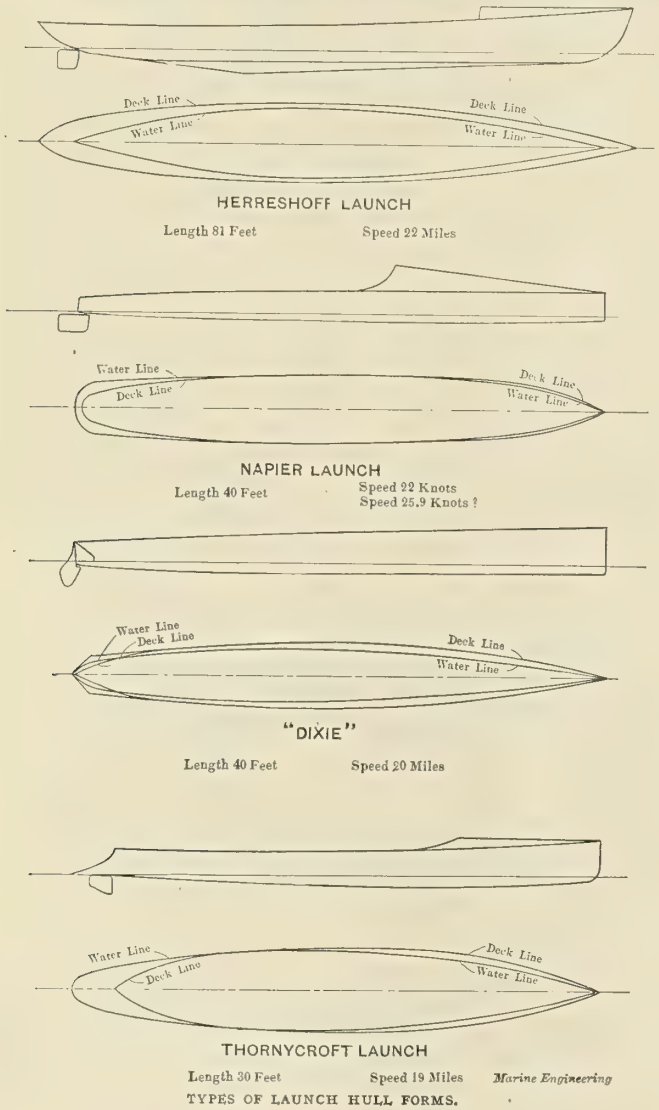
MIDSHIP SECTIONS OF LAUNCHES AND TORPEDO BOATS.

It is possible that this increase in torque may alone account for the trouble which a number of the high speed boats have experienced this summer. In designing the *Dixie* this matter was carefully considered, and she was given practically the same metacentric height as the *Vingt-et-Un II, Vingt-et-Un II's* G. M. being .725 and the *Dixie's* G. M. .675. It was expected that the increase in torque could be compensated for by the placing of the crew. In actual result *Dixie* behaves very much as the *Vingt-et-Un* did up to 21 or 22 knots. If driven faster than this in a seaway she becomes very cranky, rolling so deep as to shake the nerve of the uninitiated.

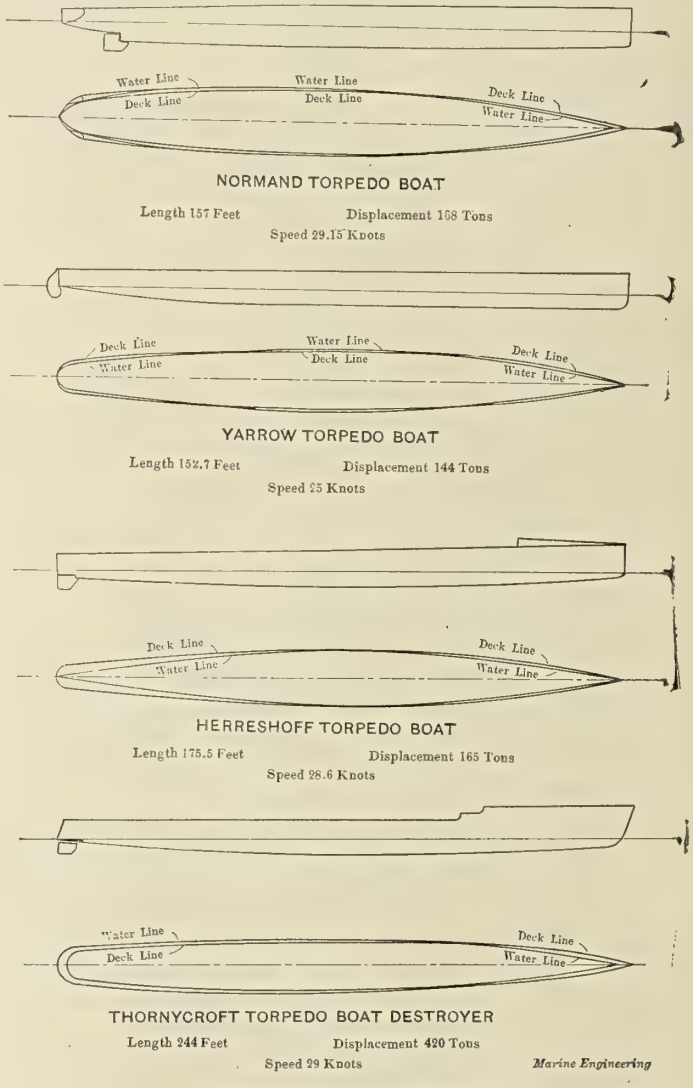
It has been found necessary on all these boats to use a comparatively large size rudder. The uneven thrust of the screw gives a very strong pressure to deviate from the course. Right-handed screws throw the stern to starboard, left-handed to port; this no doubt being partly due to the fact that the bottom of the screw is working in more solid water, and partly to the rather rank inclination of the shaft made necessary by the large power and extremely light displacement, which increases the slip on the descending blade and decreases it on the ascending. This difference of slip is as much as 4 or 5 per cent. That is, if the slip of the descending blade is 25 percent, the slip of the ascending blade would be 20 percent.

DIXIE RACING ON THE HUDSON.

In the *Dixie* we have been using a propeller, to obtain the maximum speed, of 23½ inches diameter, 32 inches pitch, with a surface ratio of 55 percent, this wheel turning 1,120 revolutions. The boat has not been raced with this wheel, as the piston speed is a little excessive for long continued running. This wheel should be perilously near the point of cavitation. As a matter



TYPES OF LAUNCH HULL FORMS.



TYPES OF TORPEDO CRAFT HULLS.

of fact I have encountered cavitation this year on a smaller wheel, running at fewer revolutions in a slower hull.

There is one more point about the shape of the model which is worth consideration. The sharp bowed boats throw a much smaller bow wave than the full bowed ones. This mass of water, although it is usually a thin, transparent film, adds greatly to the discomfort of those on board. The boat driving along at nearly 30 miles an hour against a wind and sea, this water strikes the face as from a fire hydrant.

The table which is given will be of interest. The lengths, weights, speeds and sizes of cylinders I can vouch for as being correct. The horsepowers of the gasoline engines are, with the exception of the *Vingt-et-Un II,* subject to a general calculation, and are based on the sizes of the cylinders and an assumed piston speed. They are certainly accurate within 10 percent. The column $\frac{\text{Weight in Pounds}}{\text{Horsepower}}$ is one of extreme interest. As all these boats were actually weighed by disinterested parties the results can be taken as accurate.

There are, besides the boats enumerated in this column, a number of others which as a matter of general interest should be mentioned; but I was unwilling to publish any figures unless I was certain of their accuracy.

In my opinion, for the best use we need a compromise between the extremely sharp and the extremely flat types. It is in arriving at this compromise that the naval architect can best show his skill.

A Central American Gunboat.

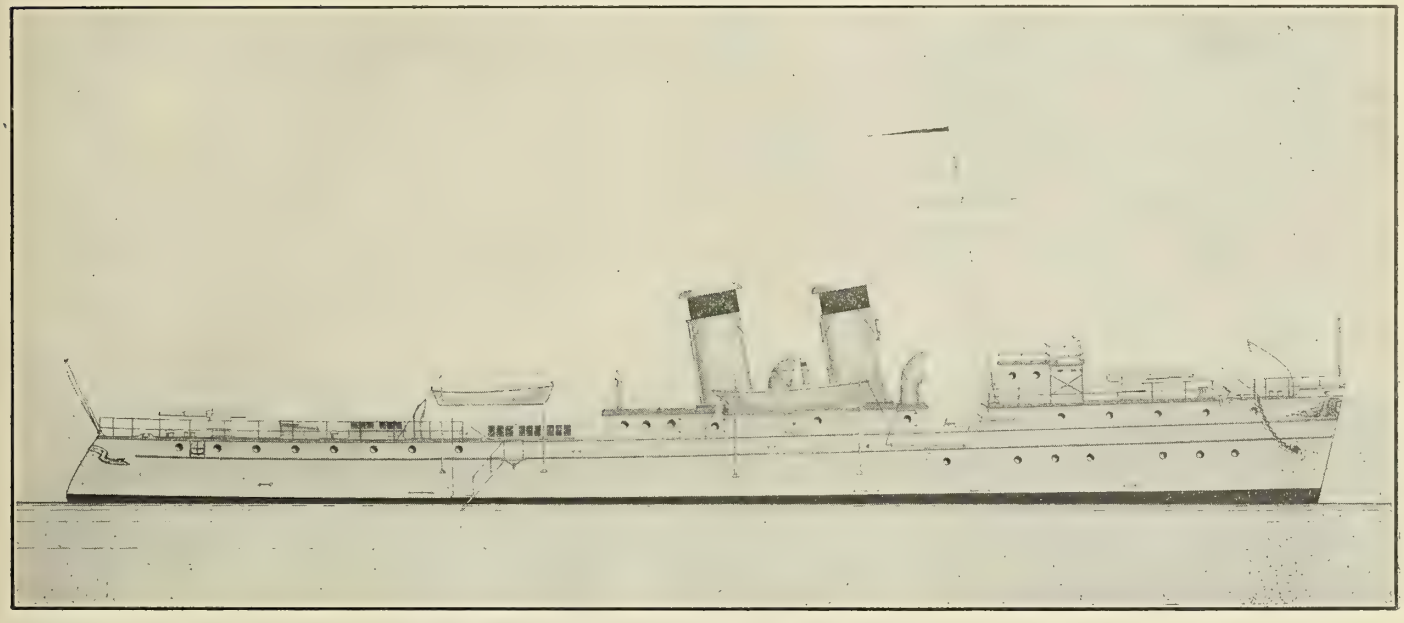
At a time when an impending revolution made it seem necessary for one of the smaller powers in Central America to obtain in a hurry a scout gunboat of high speed, designs were prepared for this craft, which we illustrate herewith. It transpired, however, that matters were settled without the necessity of resorting to any great show of force, and the boat was never built. As indicating, however, the sort of design required by one of these smaller powers for policing its coast, the description may prove interesting.

The design calls for a gunboat of 600 tons displacement, with engines capable of indicating 3,600 horsepower, and giving a speed of 20 knots. The length over all is 210 feet; length on waterline 208 feet; maximum beam 29 feet 6 inches; molded depth 14 feet 6 inches, and draft of water 7 feet. The coal supply was to consist of 175 tons, which was expected to give a radius of action of 1,350 nautical miles at full speed, and 4,800 miles at a speed of ten knots. The armament with which this vessel was to be supplied consists of two 4-inch rifles provided each with 150 rounds of ammunition, and four 6-pounder rapid-fire guns with 500 rounds each. The conning tower and coal-bunker space were protected by nickel steel plates 1 inch in thickness. The complement, which consisted of a total of 60 officers and men, included 4 navigating officers, 4 engineer officers, 6 machinists, and 46 petty officers, crew, coal passers and galley staff.

The assignment of weights was as follows:

	Tons.	Percent.
Hull, complete	210	35
Machinery, complete	170	28.3
Coal	175	29.2
Battery and ammunition	25	4.2
Equipment and stores	20	3.3
Total	600	100

The design was prepared by Mr. Martin C. Erismann, naval architect, of Port Richmond, Staten Island.



TWENTY-KNOT, SIX-HUNDRED-TON GUNBOAT, DESIGNED FOR COAST DUTY.

MOTOR BOATS, IX.

BY DR. WILLIAM F. DURAND.

THE DESIGN OF FORM (CONTINUED).

We come next to the more general and more difficult problem of including changes in the form coefficients as well as in the proportions of L, B and H. Thus it may be desired to change the character of the midship section, to fill in here or fine away there, and so in various ways to modify the characteristics of the original form. In such case it becomes a problem for the drawing board, at least to a first fairing out, before proceeding to lay down the form full size on the floor. The character and extent of such modifications may be judged by three forms of test as follows:

(1) The satisfaction of the eye as a judge of form or proportion;

(2) The satisfaction of the judgment regarding certain desired or suitable values of the form coefficients;

(3) The provision of some needed dimension or space for reasons of structure or arrangement.

If the extent of such changes is not great the original lines, or more especially the body plan, may be taken as a foundation, and the changes lightly sketched in free-hand, fining out or filling in and changing in various ways, until, as judged by one test or another, the desired form is approximately determined. If the body plan has been taken as the base for such changes, then the result on the fairness of form must next be determined by reference to the water lines, bow and buttock lines or diagonals. It will thus be found that, in order to run in smooth or fair lines on the second plan, slight changes must be made back in the sections of the body plan, still retaining of course the fairness of the latter. In this manner it will be necessary to make slight changes back and forth, the changes in one plan being tested by the results in another, until finally both or all plans are as nearly fair as may be determined on the reduced scale used on the drawing board. In making any such series of changes it must be remembered in particular that with a fair form as a foundation, a change in any one section, for instance, will necessitate a change in all the water lines in the neighborhood, and hence in order to retain the latter fair, a change in all the sections for some little way on either side of the one first affected.

The operation of thus changing back and forth between two plans, or fairing up, as it is termed, involves many minor points of detail which cannot be here considered, and regarding which experience will be the best teacher. The final purpose in any such design is the determination of a smooth and fair form with the general proportions and form coefficients selected as suitable for the case in hand, and if a form nearly fulfilling the desired conditions can be found as a start, the general procedure above outlined will serve to develop the desired changes.

We may now advance to the general and still more difficult problem of a design new from the start. It is clear that such a design cannot spring from nothing. There must be some form of initial data giving such conditions or characteristics as may serve to make possible a start toward a solution. Such initial data must then be either furnished by the conditions of the problem, or must be assumed to an extent sufficient to make the problem definite and its solution practicable. The features to be thus chosen or assumed may vary somewhat with the choice of the designer. Here as in all cases of engineering design there is no one road leading from the data to the design. There are many routes which will lead from the same starting point to the goal, and the particular route to be taken thus becomes largely a matter of individual choice. For most cases the following may be recommended as a safe and convenient procedure:

The principal dimensions, length, beam, depth, and draft are supposed to be given. The first actual step may be to lay out the form of the midship section. The beam and depth of boat amidships will give the rectangle surrounding such section, and within such rectangle a form of section may be sketched in, having in view the influence of this feature on the design as a whole, and selecting such type as may seem best adapted to the purposes in view. This step is indicated by Fig. 43.

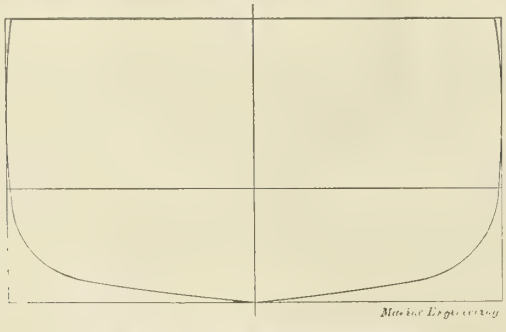


FIG. 43. FORM OF MIDSHIP SECTION.

Having thus selected the form of midship section, the next step may be to run in a sheer line and keel as shown by Fig 44, thus fixing the general contour of the boat in longitudinal section. At this stage the form of stern must be selected, whether with or without deadwood, ship form or torpedo boat form, and the keel line adjusted accordingly. The next step may be to run in a load water line *A B C*, Fig. 45, a rail line *D E C* and a curve of sectional areas *A B C*, Fig. 39. The forms of the load water line and of the curve of sections may be judged either by the eye or by reference to their form coefficients as previously discussed. It will be noted further that the curve of sections is intended to represent the areas of sections up to the load water plane; or in other words that it is intended to refer only to the part of the form lying below the load water line. The maximum ordinate of this curve, *B D*, Fig. 39, must represent therefore the area of the midship section up to the load water line, and the curve of sections should be laid down in a rectangle *A E F C*, of which the

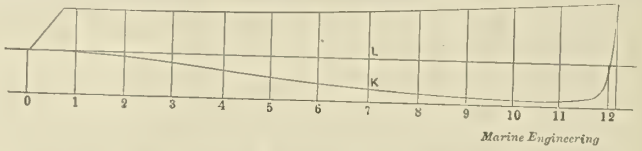


FIG. 44. BODY PROFILE OF MOTOR BOAT WITH TORPEDO STERN.

length *A C* represents to some convenient scale the length of boat on the water line, and the breadth *A E* the area of midship section up to load water line, laid off to any arbitrary and convenient scale. To the same scale therefore any other ordinate, as number 7, will represent the area of the corresponding section of the under water body of the boat.

These three features (deck or rail line, load water line and curve of sections) cannot however be selected independently, but must be taken each with reference to the others, and with reference to its general influence on the design as a whole. If the form has the ship type of stern with deadwood, the curve of sections has the characteristics of a mean or average water line. Hence in such case the deck line will be the fullest in form, the load water line will be next and the curve of sections will be fined away the most. With the torpedo boat stern these same general relations will usually hold for the fore body, while for the after body the form of load water line and deck line will be quite unlike that of the curve of sections. In any case the load water line and rail line must agree at the midship section with the form already determined for this section; but aside from these two points and the ends, which are determined by the sheer plan, these various lines are quite undetermined and must

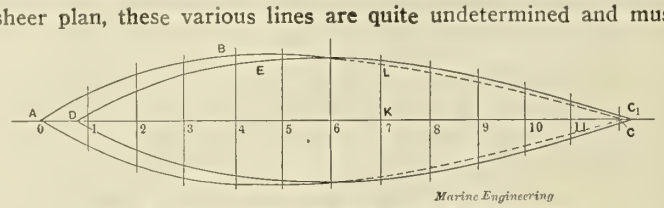


FIG. 45. WATER LINE AND DECK LINE OF MOTOR BOAT.

be laid in with the best judgment available. It is very sure, however, that the lines thus taken will not satisfactorily agree, and that all will require more or less adjustment and accommodation to bring them into satisfactory harmony as features of the design. To determine these points the design must be still further developed, and to this end we proceed as follows:

Take any section, such as number 7, and determine by reference to the curve of sections the area which is called for. Then multiply the depth of section taken from the sheer plan, *K L*, Fig. 44, by the half breadth taken from the load water line, *K L*, Fig. 45. The product will be the area of a rectangle which would just contain the half section in question. Then divide half the area taken from the curve of sections by the area of this rectangle and the quotient will give the fineness coefficient for this section and will show to what extent a rectangle *A B C D*, Fig. 46, with the given depth and breadth must be fined away to give

a half section with area as required. A little experience will enable one to make a close estimate of the shape, knowing the coefficient to be realized. Thus if the value of the coefficient is .72 it shows that *A B C E* must be slightly less than three-quarters of *A B C D*, and a little experience will make it possible to sketch in a form of section nearly fulfilling these conditions. In any case a few trials checked by planimeter will serve to bring the area to the value desired within a satisfactory limit of accuracy. In thus sketching in the form of section, reference must be made to the midship or principal section, and to the general form of section to be held in view, and also to the point *F* determined by the rail line, so that the entire section contour *A E C F* may be run in smooth and fair. In the same general manner the other sections may be run in, care being taken to make the transition in form from one to another not too abrupt, so that the general transition from the midship section fore and aft may be gradual and smooth. For this reason it is also well to start from the midship section, running in number 7, for example, quite similar in form to number 6, the midship section, and only modifying it as may be required by the slight change in area and general dimensions. Next, number 8 is run in with but slight change from number 7, but probably with a growing departure from number 6, and so on to the bow. In the same general manner the after body is determined, both above water and below. In case at any section the various lines as assumed do not agree in such way as to make the form practicable, the fact will be shown by an extreme value of the section coefficient at this point. Thus it might readily result, with the various lines as assumed, that a given section might needs be nearly or quite rectangular in form at one extreme, or triangular or less at the other. In such case the form of the assumed elements must be so adjusted as to give sections throughout having the general character of form desired.

In some cases it may be desired to keep the rail line forward especially full for room on the forward deck, or to give bearing forward when pitching into a head sea. This may be realized by introducing a reverse curve into the forward sections above the load water line, as shown in Fig. 47. In this manner, without increase of under-water body and with relatively fine under-water lines, the desired features may be realized.

When the sections have thus been all sketched in fore and aft, the result will be a set of lines conforming closely to all the conditions thus far imposed; that is, curve of sections, load water line and rail line. It is very sure, however, that a boat built to such lines would not show a smooth and fair surface, but would develop humps and hollows, flat spots and irregularities in a degree wholly surprising to one not familiar with such matters. The next step must, therefore, be the development of a smooth and continuous form, without at the same time sacrificing the conditions already realized as above. The first step in such further program may well be the determination of a series of water lines at from 3 to 6 inches interval, the first being taken perhaps at about mid-draft, and the others, above and below, being run in after such fairing up as the mid-draft line may suggest. The latter, when run in, will probably be found unfair, and will indicate needed modifications in the sections.

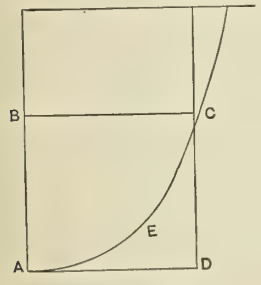


FIG. 46.

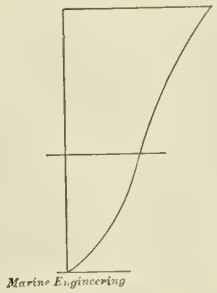


FIG. 47.

The same general series of adjustments are then to be carried out as referred to at an earlier point, in connection with the operation of fairing up after making a slight change in a given form. In the same manner other water lines may be run in and faired up, until finally the two sets of lines, water lines and sections, are as nearly fair as may be readily effected with the reduced scale used on the drawing board.

In fairing up the form about the bow and stern, much help may be derived from bow and buttock lines, or from diagonals, as previously explained. The especial advantages of diagonals are as follows: (1.) They often lie approximately in the line of strakes of planking, and thus show how such strakes will be bent, and furnish a test of fairness along these lines. (2.) The intersections of the diagonal cutting planes with the surface are usually not far from perpendicular, and the points in question are thus located more definitely than by the oblique intersections of bow and buttock lines with parts of the surface nearly vertical, or by water planes with parts of the surface nearly horizontal.

The method of developing a new design thus outlined is more especially adapted to cases in which the qualities to be attained may be satisfactorily interpreted in terms of form coefficients and the general characteristics of the curve of sections. In cases where the judgment regarding the coefficient and form of the water line and of the curve of sections may be less certain, or where the designer may prefer to proceed more directly to the determination of form, the same ultimate end may be reached by selecting first a midship section, as before, and then with pencil sketching in lightly the various sections, those of the fore body on one side and those of the after body on the other. Some guidance may be obtained by looking at a body plan with characteristics somewhat similar to those desired, and distributing the sections in a generally similar manner. By working from the midship section each way, and carefully noting the relation of one section to the next, a form may be developed which will be not far from fair, and which will possess the general features desired so far as they may be determined by reference to the sections. The fairness and continuity both of surface and of volume must then be tested by laying down from the sections a set of water lines and a curve of section areas. These will presumably reveal irregularities in the surface form, and in the distribution of volume. With such indications in hand, the sections may then be modified and faired up by means of water lines, bow and buttock lines and diagonals, and in the same general manner as before described. The resulting coefficients of load water line and of curve of section areas may then be determined, and the values applied as a test or basis of judgment regarding the general character of the form thus developed.

The method first discussed involves the selection of certain features and conditions which the form is to fulfil, and as expressed by the form coefficients and the curve of sections, and then determining a form which shall realize these requirements as nearly as may be finally decided desirable. The second method involves the determination of a form direct from the midship section and without other guide than the eye, and then the testing of this form by reference to its coefficients and curve of sections, until the result shall finally be accepted as satisfactory for the case in hand.

In earlier years the forms of boats were commonly determined by working out a model in wood, and to such reduced scale as might be convenient. This method has the advantage of permitting eye judgment of the solid form, and this is always more satisfactory than judgment in the flat, as on the drawing board. It has the disadvantage that the form must be developed almost wholly by eye judgment, and without initial help from the various form coefficients; also, should the form be made too fine at any point, the error is not readily corrected. On paper, lines may be run in and rubbed

out, and the form may be modified in any manner desired, without prejudice to the completion of the problem along any line which may be finally chosen. It is readily seen that with a wood model there is very much less freedom of adjustment and change in this manner, and if patching is to be avoided, great care must be exercised in approaching the final condition, lest a spot undesirably lean may be produced.

If, however, it should be decided to develop the form of the boat by means of a model, such method should be considered only as a first step to the determination of the half-breadth and body plans on the drawing board, and from the latter the coefficients and geometrical characteristics of the form may be determined as previously described. The ordinates, or measurements for laying down these plans, may readily be taken off by calipering, especially if the model is made with lifts as explained below. The form thus produced direct from the model may then be judged by means of these coefficients, especially with reference to the relation between draft, displacement and carrying capacity.

On the other hand, when the form is produced on the drawing board, especially if it contains features of novelty, it may be recommended to make a model before laying the boat down full size and proceeding with the construction. This operation is the inverse of determining the lines from the model. The operation of cutting a model to represent a set of lines is one requiring some considerable skill, and involving many practical details. Within the present limits we may note briefly the following points:

Two general methods of procedure are open:

(1.) A solid block may be glued up, and then pared down as tested by concave moulds cut out to fit the form of the sections, and applied to the model at the corresponding stations. In this manner the block is reduced to the desired form at a series of regularly spaced stations. The intermediate parts are then brought down, and the whole faired up.

(2.) A series of "lifts," or boards of thickness to represent the space between the water lines, is prepared, and the water lines laid out one on each. The lifts are then cut out, each to its own form, and these are then pegged together or glued up, as may be preferred. The corners are then brought down so that the form is smooth and continuous and with water lines as determined. The indications of such a model will often suggest slight changes in the form, and this may be done on the drawing board and followed up on the model, until between the two the resulting form seems to satisfy the judgment taken from all possible points of view.

However the model may be derived from the lines, it may be recommended to always lay up the block out of "lifts" in the manner suggested for the second mode of procedure, and to color the glue with black. This will give on the model definite fine lines in black representing the water lines and aiding the judgment somewhat with regard to the form of the boat along these lines.

In fixing upon the various preliminary characteristics of the design, both draft and total depth will present themselves for consideration. The important question may then arise as to what assurance we may have that when built the boat will come to the draft designed. Definite assurance on this point can be acquired only by elaborate calculations and estimates regarding the weights of boat, machinery and equipment. In the absence of such estimates it may be safely assumed, if the general proportions and character of construction are in accord with common practice, and if the boat is powered within reasonable limits, that there will be left over a certain margin of carrying capacity before bringing the boat down to her designed draft. Such margin may then be utilized for passengers, etc., and should provide for all ordinary requirements with a boat of this character. It is not to be expected, of course, that any boat will naturally or necessarily run at just the designed draft. With small boats, in particular, there is often much variation according to the load carried, and so long as the freeboard remains sufficient for safety, the fundamental purposes of the boat may be considered satisfactorily fulfilled.

THE DEVELOPMENT OF THE TORPEDO-BOAT DESTROYER.*

BY W. J. HARDING.

I think it may be claimed that in building destroyers our nation is pre-eminent, and though shipbuilders and engineers often meet on cosmopolitan ground and compare and freely impart ideas, I think our national egotism may fairly claim that in the matter of construction of torpedo-boat destroyers we lead the world. I would remind you that the River Thames and the Solent first gave us what is called a "torpedo boat," and though the area of production has been very much enlarged, it can certainly be claimed that the productions of those localities are still in the front rank.

From very early times the glamor of the torpedo—or the "infernal machine," as it has been called—has occupied people's attentions and prompted its usage; for the idea is that you may, by a sort of "hitting below the belt," destroy your enemy with but little risk to yourself; and, further, when there is risk involved, it would be borne by only a very small number of assailants, and that in fact, as represented by the novelists and others, risks to each individual may be less than that of the players in a football scrimmage.

I need scarcely say that torpedoes may be classed as fixed and moving. Of the fixed ones our experience as a nation was gained during the Russian war of the fifties, when at least one of our ships was slightly injured in the Baltic by the explosion of a torpedo under her, and some officers and men were injured by the explosion of captured torpedoes while they were being taken apart. During that war also was used what may be described as a moving torpedo, one of our sailor men being credited with swimming into the harbor of Sebastopol and fixing an infernal machine under the counter of a line-of-battle ship, for which bravery he was rewarded; but I believe the ship was not blown up.

In 1858 our navy had experience of a moving torpedo, a Chinese invention. H. M. S. *Niger,* while lying in Fatee Creek ready for the bombardment of Canton, was torpedoed by a moving junk filled with gunpowder, etc., towed from each bank of the stream and cleverly placed under the bow of the *Niger* and exploded. The damage inflicted was more moral and intellectual than physical. And of other fixed and moving torpedoes we have lately had knowledge in the operations in the far eastern seas.

I may also remind you that the moving torpedo, carried on the end of a spar, was used during the civil war in North America, notably when Commander Cushing blew up the Confederate warship *Albemarle.* Another attack by the Confederates, in 1864, with the spar torpedo, was successful in sinking the Federal man-of-war *Housatonic,* the attacking boat being sucked into the breach made by the explosion and also foundering with all hands. Also during that war there were several cases of ships being destroyed by anchored mines.

After that we had the Harvey towing torpedo, which was an adaptation of the canal barge towed from the bank, or of what is known as the salmon poacher's "otter" with baited hooks, the poacher walking along the river's bank and towing his otter, which keeps mid-stream, and so catching his salmon. These otters can also be made to alter the direction of their motion by a strong pull on the towing line, which enables the poacher to retrace his steps, still towing his otter mid-stream. After that we had the Whitehead invention, which has necessitated alterations and additions both to tactics and to shipbuilding.

*Read before the Institute of Marine Engineers, March 13, 1905.

Not always has perfection been obtained without early fatalities. We had in our navy a very promising officer, Lieutenant Meade, brother of the present Earl Clanwilliam, blown up when manipulating a torpedo of his own invention in the sixties. And later on in the seventies, we had an engineer officer killed and another maimed in working the Whitehead apparatus, due to escape of compressed air. There have been other incidents giving maiming of limbs, which is a toll learners have had to pay in manipulating these and other deadly weapons; and happily the history of our navy shows that whether boiler explosions, machinery disasters, or other incidents giving mortality, there are always many living volunteers to take a dead man's place.

The Whitehead torpedo is fairly well known. This is the invention of a marine engineer, and is a weapon which marine engineers are most aptly fitted to manipulate. Its original propelling apparatus was by compressed air working compound oscillating engines and driving a single propeller, giving rather a low speed.

The first vessel in the British navy for using this torpedo was the *Vesuvius*. This was a vessel low in the water, having a peace

UNITED STATES TORPEDO BOAT DESTROYER WORDEN AT FULL SPEED.

funnel of the ordinary type pointing to the sky and a war funnel horizontally along her deck to discharge smoke right aft. She was fitted with induced draft. She had a submerged torpedo tube pointing right ahead, from which the torpedo was ejected by a telescopic apparatus actuated by compressed air. It was early seen in this vessel that the speed of the torpedo should be increased, for it is one of the legends of the navy that when she did fire an actual live torpedo from her tube at a hulk, she being under way, those looking over the bows of the vessel saw that the *Vesuvius* would soon overtake the torpedo, and perhaps be blown up herself. Higher speeds of torpedo were afterward obtained by adopting the Brotherhood three-cylinder engine, and this has been continued.

The development of the torpedo boat and destroyer is due primarily to the fact that it was found that these Whitehead torpedoes could be discharged from above water. The first experiment was made from the deck of an old sailing vessel, the torpedo launched, and the regulating valve for the engine tripped as it passed over the side, when it was seen that the torpedo dived and soon regulated itself to the depth required and propelled itself in a straight line. From this was evolved the ordinary deck torpedo tube now used in torpedo boats and destroyers.

The torpedo "drop gear" fitted to vedette boats, etc., was an adaptation invented by Engineer Rear-Admiral J. T. Corner, and is an arrangement of tongs which is lowered from the boat's side, submerges the torpedo, and on tripping its regulating valve, thus setting the propeller in motion, releasing the tongs at the same time, the torpedo starts and soon finds its depth. These vedette boats of wood of 1878 were 48 feet long and 12 knots speed, and have been developed to 56 feet long. Special boats of this class, by J. Samuel White, of Cowes, have obtained 19 knots on trial.

About 1873 some very fast vessels began to be constructed on the Thames. These vessels were marvelous in their low weight and high power. They completely upset the theories which are written in some books on naval architecture, in which it was laid down that speed at sea could be obtained only by enormous increase of dimensions of the vessel, and it was inferred that the speed of small vessels could be put to only a certain limit, dependent on length.

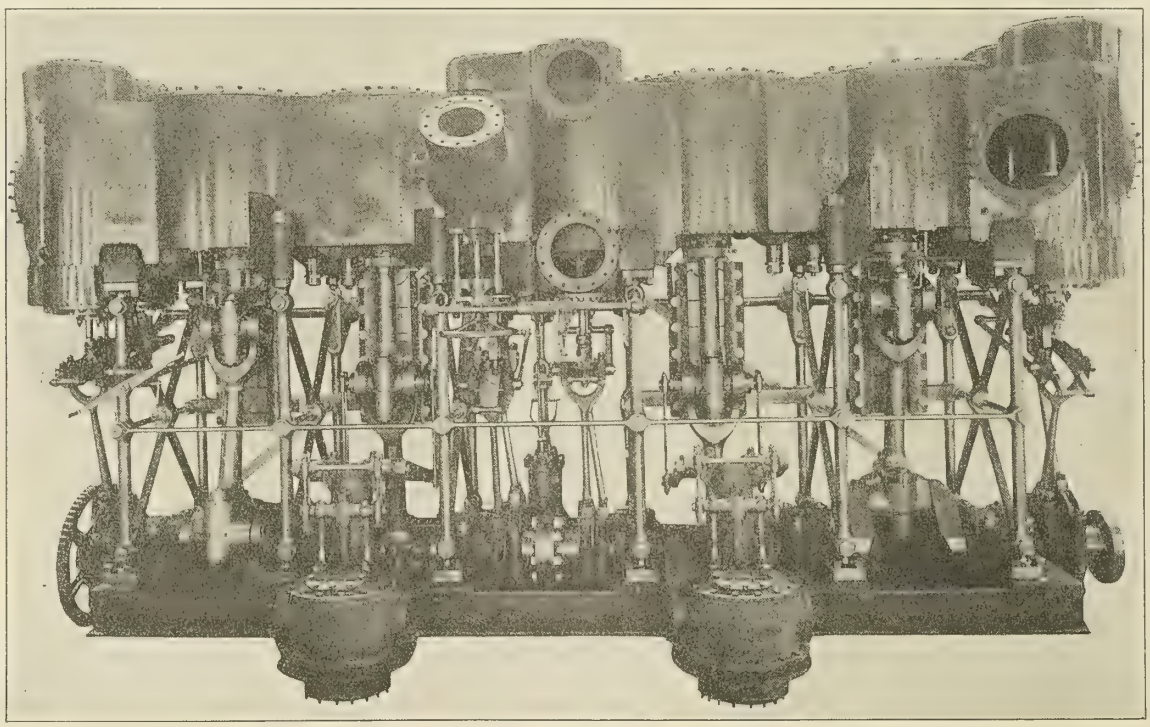
In 1875, Messrs. Yarrow constructed a torpedo launch of the then high speed of 13 knots, fitted with a spar torpedo, and made a war test by blowing up a barge on the Thames prior to shipment and delivery to a South American power. Sir John Thornycroft was the builder of the *Miranda,* in 1872. This vessel was 45 feet 6 inches long, and obtained a speed of 16.2 knots per hour. This firm constructed the first large torpedo boat for H. M. Navy. She was the *Lightning,* completed in 1877, her length 87 feet, speed 18 1-2 knots, and she did many years of constant service at Portsmouth. Also in 1877 the Russian government obtained from home and two foreign firms 100 torpedo boats. A large number of these were built by, or to the design of, Messrs. Yarrow, celerity being required. They were 75 feet long by 10 feet beam, were required as small as possible for keeping the seas for a few days, and also adapted for transmission by rail. The first boat tried on the Neva obtained 18 knots speed.

Following the *Lightning,* various batches of boats for our navy were constructed at various times up till 1889. These were by Messrs. Thornycroft, White of Cowes, and Yarrow. Their lengths were from 113 feet to 130 feet, giving horsepowers from 730 to 1,100, and speeds from 20 to 23 knots. Some of the earlier and shorter of these were dispatched to various stations—China, Cape of Good Hope, Australia, North America, India, etc. Most of these voyages were under their own steam. The longest

voyages, from England to Vancouver Island via Sandy Point, were performed by two Yarrow boats. There were no incidents during these voyages engendering mistrust as to strength of hull. As to the crews, their normal state may be described as "dirty, but happy." In connection with this matter of strength of hull, of the destroyer class especially, it is much to be regretted that alarm was some few years ago created by irresponsible and untechnical writers—some of them neither naval nor expert, though called naval experts—who argued from wrong premises and preached ideas which, if followed, would cause a most useless and wasteful expenditure of public money.

In the Chilian-Peruvian war, 1879-1881, spar torpedo boats were employed by both combatants. The blockade of Callao was commenced at about 5 A.M. on April 10, 1880, by the Chilian Thornycroft torpedo boat *Guacolda,* an 11-knot craft, attacking the Peruvian man-of-war *Union,* which was surrounded by timber booms. The boom was shattered, but the small-arm fire drove off the torpedo boat.

The gallant but unready Peruvians had only makeshift craft, which did good work, in that they caused the Chilian blockading



FRONT VIEW OF ONE FOUR-CYLINDER TRIPLE EXPANSION ENGINE OF WORDEN.

fleet to proceed to sea daily at sundown and spend the night in a safe offing, the entrance to Callao Bay being patrolled by Chilian torpedo boats. In the middle watch of May 25 of that year, a Peruvian spar torpedo launch, some distance from the shore, was surprised by the *Guacolda,* which chased her. The 18-knot Yarrow boat, the Chilian *Janeques,* also chased and overtook the Peruvian, the result being that the Chilian was torpedoed and sunk, and the Peruvian foundered when returning. Gallant Lieutenant Galves, badly wounded, and seven of his crew of sixteen were rescued by the *Guacolda;* his surgeon, Uriarte, and eight men were killed. The surgeon was given an impressive public funeral in Lima. The Chilian loss was two men, the remainder escaping in boats seized from a vessel lying in the out-of-fire zone.

It will be remembered that this war was remarkable for the destruction of two vessels by torpedoes. In one case the transport *Loa* captured a coasting barge adrift full of vegetables, fruit, poultry, and other good things, which were heartily welcomed by the crew, who had had a long diet of sun-dried beef and biscuit. On examination of the barge it did not show any explosives; but as the welcomed cargo was unloaded from the barge alongside the *Loa,* mechanical arrangements were such that when the weight in the barge had been very much reduced an explosion ensued, which blew in the side of the *Loa* and sank her with loss of life of 145 men of a crew of 200.

Another case was the *Covadonga.* She had been captured from the Spaniards by the Chilians many years before by a deception, and another deception was her doom. This vessel captured a little skiff which was adrift, and, in hoisting her on board the *Covadonga* was dynamited and sunk. There were moving torpedoes supplied for that war, but they did no destruction. They were of the "awash" principle, controlled from a station by wire. They were not regarded as satisfactory by the Peruvians. In one case it is said that one got out of control and returned toward the Peruvian ship *Huascar,* from which it was being operated, and only the gallantry of Lieut. Diez Canseco of that ship saved her, he jumping overboard and diverting the torpedo. The Peruvian Admiral Grau was so disgusted by these weapons that he landed them and buried them in the public cemetery at Iquique.

Later, in 1891, in those South Pacific waters, the Whitehead was used. In one case a Whitehead was fired from a picket boat at a large Chilian mail ship, but did no damage, being found next morning minus its head, no explosion happening. But the ironclad *Blanco Encalada* fared worse. Some six Whiteheads were fired at her, of which one only seems to have struck, and its charge of 58 pounds of guncotton knocked a hole in her side 15 feet fore-and-aft by about 7 feet high. She sank in less than five minutes, losing 150 officers and men. Of the eleven officers missing six were engineers. The only engineer who was saved was washed up one of the ventilators. Later on in that war a spar torpedo picket boat was destroyed by the explosion of her own torpedo, and five men were blown up or drowned.

In 1893 torpedo warfare was conducted on the Brazilian coast. The ironclad *Aquidaban* was struck forward by a fish torpedo having 125 pounds of guncotton, which caused the two forward compartments to fill but did not sink her. In this case one hit in four discharges was given.

The precursor of the destroyer class was evolved about 1884. Hitherto the plan had been to give torpedo boats an alternative armament, so that half of the boats might be employed for firing torpedoes, the others acting as torpedo-boat destroyers, the boats

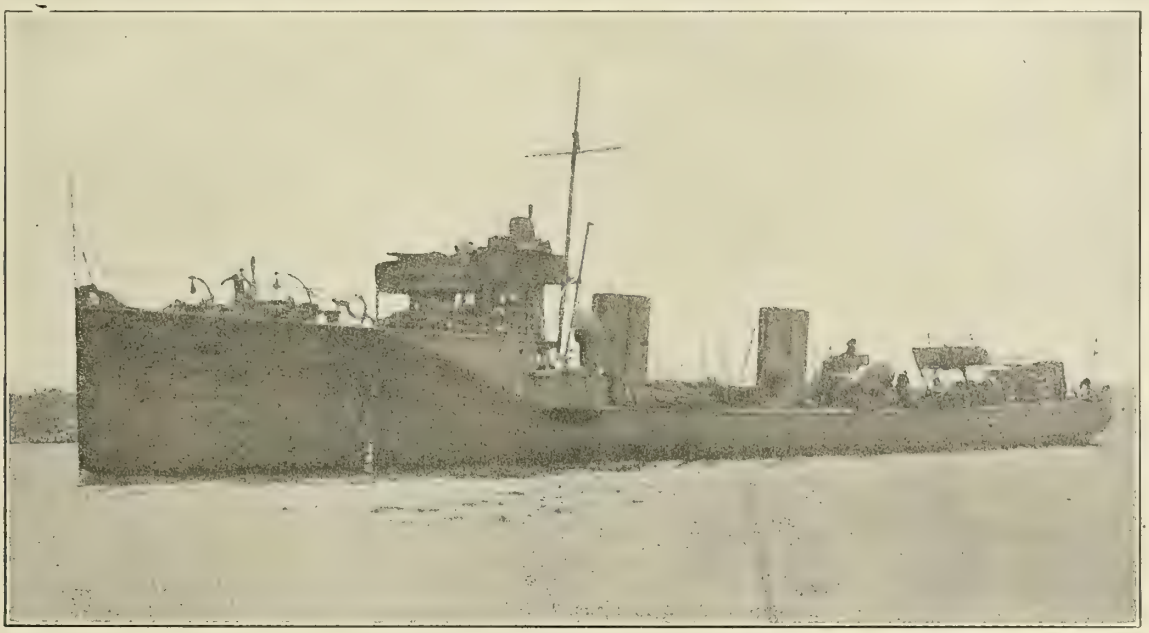
armed by the small guns resisting attacks of torpedo boats. But as the speeds would be about the same in each, it is evident that neither could decrease the range of the other when attacking or escaping. Perhaps the first approach to the destroyer was the production of John Samuel White, of Cowes. This was a vessel added to the British navy in 1885. She was 150 feet long, and so larger than boats hitherto in use, which were single-screw boats. She was fitted with twin screws and with more power—a larger vessel and better sea boat and of higher sea speed than they. In the British navy she did good work as the commodore of the flotilla.

Another vessel, 200 feet long, 2,900 horsepower, named the *Sea Serpent,* was also laid down by that firm in 1885, and obtained a speed of 23.8 knots with a load of 20 tons, and 21.5 knots with a load of 90 tons. The curt term "destroyer" not then being in use, she was termed an "exaggerated torpedo boat." At that time *Rattlesnakes* were in fashion, but the "exaggerations" are now a survival of the fittest. Her speed was a little disappointing, the shallow water of Stokes Bay not favoring speed. Also, if subsequent knowledge as to material of propellers had been available, she might have obtained 25 knots, and so fulfilled most of the conditions which were afterward required in torpedo-boat destroyers. She was eventually acquired by the Chinese.

Messrs. Yarrow & Company constructed the *Kotaka* in 1885 for the Japanese government. She was 170 feet long and fitted with twin screws, and practically an armored destroyer, being fitted with armor 1 inch thick around the machinery and boiler compartments, sufficient to resist the fire from the torpedo boats as then armed. This vessel led the attack, with other torpedo boats, on the Chinese ships at Port Arthur. It is not generally known that in that Japanese attack the weather was so bitterly cold that it actually froze the sea-sprayed torpedoes in their carriages, and that of eight torpedoes which were attempted to be fired against the Chinese men-of-war only two were actually fired, the others being frozen in their tubes, and could not be ejected till thawed out. Perhaps in reference to this incident I may suggest that the recent operations in China seas have also been very much influenced by the freezing weather, for engineers well know that compressed air in escaping is frozen, and that where compressed air is used for operating machinery the exhaust pipe must be very short, and to carry a Whitehead charged with compressed air which will rapidly assume the temperature of the surrounding atmosphere, which may be initially several degrees below freezing point, this expanded air exhausting from the Brotherhood engine through a long hollow propeller shaft, may cause such freezing in that shaft as will decrease the speed and range of the torpedo, and perhaps render it inoperative.

About 1893 the British navy gave orders for torpedo boats which were to be of higher speed than hitherto; and not only of higher speed, but to obtain this speed carrying a greater load than before. These boats were *Nos. 88* to *97* of our navy, constructed by Yarrow, Thornycroft, and White, and one of them by Laird, of Birkenhead. Some were fitted with locomotive boilers; those by Thornycroft with water-tube boilers; one by Yarrow also with water-tube boilers. Trials of these vessels showed that certainly for this service the water-tube boiler was far preferable to the locomotive boiler.

About this time also the "torpedo-boat destroyer" was evolved. Practically these destroyers were given just double the power of the latest torpedo boats in being. The hulls were built round them with due regard to the armament and the weight to be carried on trial, and also, of course, with due regard to the fact that they would be expected to be more sea-going. The draft was restricted to 5 feet, giving immunity from destruction by Whitehead torpedoes, which are erratic and inclined to "porpoising" if set to run at 5 feet depth or thereabout. They were armed with guns and Whiteheads, and so were calculated to destroy not only torpedo boats but battleships. This batch of destroyers, originally confined to Yarrow, Thornycroft, and White, was afterward spread all over the country. They are fairly well known to most engineers. These expanded an industry which required high technical knowledge and superior handicraft.



BRITISH RIVER TYPE TORPEDO BOAT DESTROYER EXE.

Observers of the building of these hulls will note that with the very thin plates as used it is absolutely necessary to manipulate those plates to give the requisite strength to resist any alteration of form. A five pound plate—that is, ⅛ inch thick—is a very limp object when received from the cogging mills, but after it has passed the leveling slab and been leveled it becomes very stiff; and its actual tensile strength is not in any way altered, while its strength to resist bending is very much increased, the leveling or "planishing" rendering the plate extremely stiff; and it is this knowledge of building among the workmen employed which is noticeable in various vessels, those built from longer experience being certainly stiffer and better vessels than those not having the benefit of that experience.

This paper is not intended to enter into the dimensions of scantlings employed, but perhaps it would be interesting to note that in the 27-knot destroyers built of galvanized mild steel

plates, with tensile strength 30 tons, the thickness of garboard strake is 6½ pounds; sheer strake, 9 pounds; deck plating, 6½ and 8½ pounds per square foot. Afterward a harder and stronger steel was used, which was more difficult to manipulate. This increased the cost of building, but permitted lighter scantlings, comparatively. This latter steel was 40 tons tensile strength. Its riveting was much more difficult with the hard rivets used; they required more knocking down, and the riveting was not so comely and smooth.

These 27-knot destroyers were of various lengths from 180 to 190 feet, the horsepower varying from 3,700 to 4,800. It may be mentioned that there was great public interest aroused, not only by the ordering of these boats, but from the fact that some men who seemed to have knowledge actually expressed their views as to the speed being unobtainable; and in one case simultaneously with such assertions that the speed was not obtainable there came the actual news that the *Havock,* by Yarrow & Company, the first of the destroyers, had obtained a speed of 26.2 knots. This vessel (length 180 feet, beam 18 feet 6 inches, depth 10 feet 6 inches, and displacement 240 tons) showed what could be done with least displacement, with least power, and with the least coal consumption, toward carrying the armament required at the speed required. The larger vessels carrying the same armament with greater power and with a much greater coal consumption also gave the same speed of 27 knots; and though it may be asserted that the large vessel has advantages over the smaller one, primarily in the matter of habitability, I would put it that the vessel doing the work on the least displacement and with least coal consumption is certainly a triumph of brains, if nothing else. I also think that such a vessel should initially cost less than a larger one—certainly she should cost less for maintenance.

One important improvement introduced by Mr. White, prior to the year 1883, is a feature in all subsequent torpedo boats and all destroyers. This is the cutting away of the dead wood at the stern, thereby securing a maneuvering power that would otherwise be scarcely possible, coupled with a more efficient feeding of the propellers so essential to high speed. It is well known that from 1891 to 1896 the trials of the 27-knot destroyers were chronicled in the newspapers, and each seemed to go one better than the other.

In the matter of speed, the highest on the measured mile was given by the *Boxer,* by Thornycroft, the speed obtained being 29.1 knots with 4,490 horsepower. In the matter of coal consumption, the lowest was the *Hornet,* by Yarrow & Company; she burned 9,322 pounds per hour, giving 27.6 knots, the highest burning 17,122 pounds per hour, giving 27.4 knots.

All these trials were full of very interesting incidents, and one thing they taught was that the very best material, and certainly the very best workmanship, was indispensable, coupled, of course, with the most talented brains in the drawing office. For the "spoke-shaving" was such that between success and failure was almost at times just the thickness of a sheet of paper. In the matter of machinery trials numerous incidents might be mentioned. I should like to say this, having observed some of the trials—and I am not alone in my opinion—that the way in which youngsters, apprentices, and young journeymen, tackled the duties which were placed upon them, and tackled them with a knowledge that occasionally there were accidents which might produce maiming, was certainly good to observe from a national point of view.

Better pens than mine have told of the fair-haired public school boys and others doing their duties among the machinery in a most laudable manner, including the son of a belted knight in the stokehold oiling the fan engines, and certainly covered at the end of the trial with a coating of oil and coal dust perhaps weighing 2 pounds to the square foot of flesh and clothing; and I might also mention one case of several apprentices who did the coal trimming in the bunkers for a long trial rather than forego the trial by waiting for coal trimmers who did not turn up. So much for the personal element.

BRITISH DESTROYER BOYNE AT FULL SPEED ON TRIAL TRIP.

It was my great honor to take Mr. Rudyard Kipling into the engine room of a Thornycroft destroyer on trial. He seemed to be much impressed by seeing engines with 18-inch stroke doing 400 revolutions in an apparently small space, the eight connecting rods each making 800 swings a minute, faster than the eye could follow. He said that he had come to the conclusion that the youth who wished to become an engineer was prompted not so much by love of pelf, but from seeing the creations of engineers do such work as this and to be identified with it. He also compared the engine room with the 500 bewilderments of ill-livers deceased, as preached in some tenets.

I might mention many incidents which occurred during these trials, showing that high-grade workmanship was required, and also showing how negligent workmanship cost many golden sovereigns to the shipbuilders. Boilers, engines, condensers, shafting, and screw propellers, all gave little troubles, and all gave valuable pointers for improvement in the future.

As regards the boilers, it was proved that the locomotive boilers gave excellent results up to a certain grade of coal burning, and at

slow burning they were very economical, but the tube ends could not be depended on to remain tight. These troubles were not experienced in water-tube boilers, which were of various systems, some with straight and some with curved tubes. Practically all showed their superiority over any type of locomotive boiler which had hitherto been used, when forced to the utmost extent of their coal-burning capacities. Nevertheless, the locomotive boiler gave 1 horsepower for 1.33 square feet of heating surface, as against a maximum of 2.58 square feet in a water-tube boiler.

Usually incidents in the engine room were due to inefficient lubrication. It is generally well known that the oiling was supplemented by men with syringes, and there was no stint of oil. So large a quantity was used, that, if named, it might cause a great deal of horror to those who are wont to be economical in the engine room. I can, perhaps, mention only that in a foreign destroyer, modeled something after the English pattern, the engine-room department is credited with having used 450 gallons of oil in three hours, so that at least they must have been pretty attentive to the oiling. Our records do not chronicle such a high consumption.

If the white metal of the crank-head at any time ran, it was very advisable to stop the engine dead, as otherwise unpleasant consequences ensued. Generally it may be said that all oiling arrangements were made with a view to keeping oil in the journal. That is to say, the oil channels were stopped short at the ends of the bearings, and the liners between the brasses were in some cases made to fit close, if not touching the crank pins or journals, so that the oil could all be retained between the rubbing surfaces, and only weep away at the ends.

Some trouble was experienced with surface condensers, principally in the matter of split tubes, some splitting before, some splitting during, and some splitting after a trial—as a consequence producing boiler trouble from brackish feed. I think it may be said that the troubles of water-tube boilers arise primarily from faulty surface condensers, and had satisfactory condensers been in vogue when water-tube boilers were first adopted, there is no doubt that much public discussion on the great water-tube boiler question would have been avoided.

The form of surface condenser used in destroyers is well known, a few having double flow of circulating water and the majority having a single flow. My opinion is that those having the double flow—that is, having short tubes—have given less trouble than those having the single flow with long tubes. Even the most hypercritical inspections and testings of condenser tubes before building the condenser failed to obviate all trouble. There is such a little difference between those tubes which act well and those which act badly that it can hardly be detected. Toughness, combined with requisite hardness, is what was aimed at, and in some cases hardness verged on to brittleness, and brittle tubes became split.

The quality of the material may be fairly well tested by taking a short piece and cracking it in a vise. Those which compress to a certain limit and crack in only two places give better working than those that compress and crack in three places. A good, tough tube of the required hardness should be capable of being flattened with water pressure test of 300 pounds inside of them without fracture, and pieces flattened in the vise should bear a certain amount of flattening without fracture, and the alteration in dimensions at fracture should point as to the quality of the tubes. It is well known that in the larger ships of His Majesty's navy, it has become a practice to fit two condensers to each engine, so that if one becomes defective and gives salt feed it may be shut off and rectified, the remaining condenser giving a fair amount of power, though reduced.

I look forward to the time when our present Hall's surface condensers will be abolished, and I have had an opportunity of seeing an invention toward this end. By the kindness of Messrs. Caird and Rayner, I have viewed a new type of condenser, which will enable condensers being built in groups each of 1,000 horsepower, and each and every one of these may be disconnected at any time for examination and repair, whereas with the present surface condensers examination of the thousands of square feet of internal and external surfaces of the tubes is almost an impossible operation. With the condenser of Caird and Rayner, I note that such may be taken apart in a few minutes, and the whole of the internal and external surfaces of the cooling area examined, corrosion noted (if any), and the surfaces cleaned and rendered efficient.

UNITED STATES DESTROYER MACDONOUGH ON TRIAL TRIP.

As well as split tubes in the torpedo-boat destroyer's condensers, we have had occasionally ferrule slackening, due, no doubt, to vibration. This was overcome in some cases by the invention of the Thornycroft ferrule. Of all the systems, however, I prefer the Yarrow system, in which the tube goes right through the ferrule and has a small wire guard to prevent slackening of ferrule, and it has the great advantage of giving an unimpeded flow of a full bore of water through the tube. The ordinary ferrule now in use would not give this, as there must be some eddying at the entrance of the tube.

Occasionally there were twisted shafts, about which there were many opinions, some holding that the shafts were not strong enough, and some holding that the longitudinal vibration of the vessel tended to seize the shafting in the bearings, and so produced twisting.

Most valuable lessons in fatigue of metal were learned. Stresses which, if once applied, would give no indication of ultimate fracture, were found to produce fracture after thousands of

such stresses. These were principally by bending. I may mention that in bolts with reduced shanks, which were supposed to stretch a lot before breaking, I never saw any such stretching, the bolts generally fracturing near the end of the screw thread. Had there been such stretch of material, some disasters might have been averted.

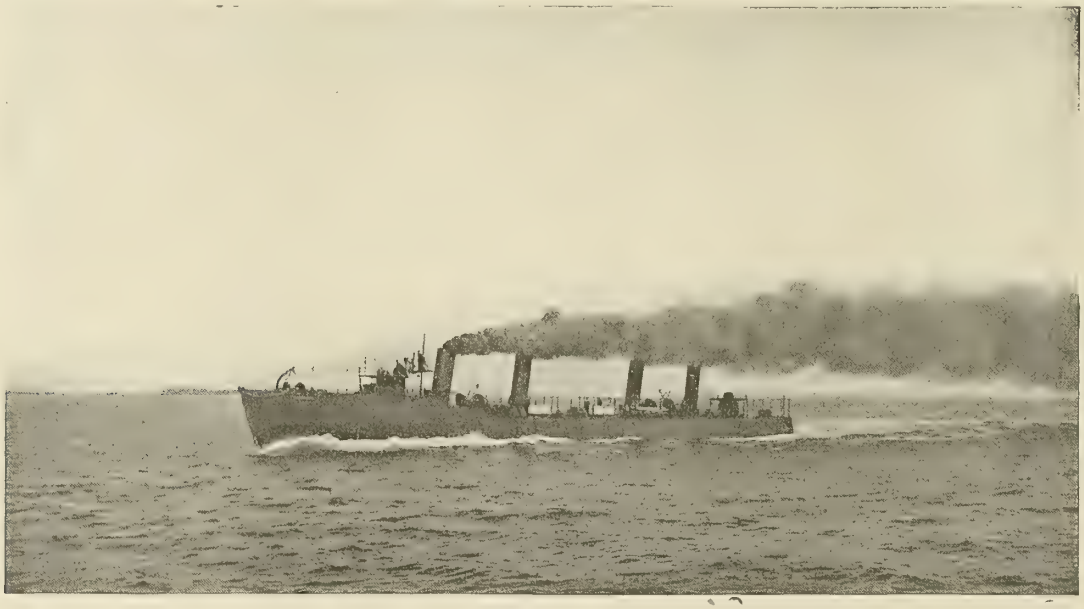
But above all, those trials gave most valuable lessons in screw propellers. It had been customary in torpedo boats and prior boats to make propellers of forged steel, but the substitution of manganese bronze propellers of practically the same dimensions gave the then marvelous result of an increase of speed of about two knots. At 384 revolutions per minute the forged steel propeller gave 24¾ knots; the manganese bronze propeller at the same revolutions gave 27 knots in the same vessel at the same draft.

Other items as to the various ratios to be used—namely, the ratio of pitch to diameter, and the area of the blade as compared with the area of the propeller disk—also became apparent, showing the direction in which improvement might be effected, as well as indicating other suitable dimensions. Generally, the knowledge gleaned was that each time the propeller was fined there was a gain, and each time the propeller was decreased in diameter, improvement was given: (*a*) diameter increased 4 percent, area increased 19 percent, pitch not altered, the coal bill was decreased 27 percent at equal high speeds; (*b*) pitch fined 6 percent, no other alterations, gave the same high speed with 10 percent less indicated horsepower, and 17¾ percent less coal bill, (*c*) diameter increased 2 percent, pitch fined 9 percent, gave ¾ knot more speed, and coal bill decreased 40 percent at the same high speed obtained by the first propeller.

I suggest that the torpedo-boat destroyer experiments might be regarded as model experiments on a very large scale, of which the expense was borne by the contractors, and the result is that many larger ships, both naval and mercantile, are now having much more efficient propellers fitted—perhaps from this experience. The words of Sir W. H. White, uttered twenty-one years ago, were prophetic: "In these torpedo vessels we have no doubt the pioneers of future navigation at higher speeds than have ever been attained."

The load carried on these 27-knot destroyers was 30 tons. This was a task heavier than had hitherto been the practice in any navies.

In this matter of propellers it will thus be seen that when 27-knot destroyers are loaded down to their war-service draft their



UNITED STATES DESTROYER BAINBRIDGE MAKING 29 KNOTS ON TRIAL TRIP.

meter, retaining the same pitch, there was a loss. To a certain ratio the area of the blade could be increased with advantage, provided the engine would turn the propeller round. Practically, whenever the slip was decreased by fining the propeller or by fining and increasing its diameter, or perhaps by fining, increasing its diameter, and adding more blade area, there was an improvement not only in speed, but in the coal bill.

Vibration was found to be modified by the propeller used, by the position of the blades with respect to the cranks, and by pitch deviations in each blade. The speed of no slip was important.

These experiments showed that if only the indicated horsepower were required, the propeller could be fitted which would give perhaps 20 percent more horsepower than an ordinary propeller. If the speed were required, a very different propeller would be adopted; but if speed coupled with a small coal bill were required, the propeller between these two would give the best results. Also that the proportions of the propeller influenced the coal per indicated horsepower, the coal per indicated horsepower propeller lacking in propulsive effect. The least immersion of the propellers gave the best results both in speed and coal bills; and the distance apart of twin-screw propellers was of moment.

I may give comparative instances of propellers showing how trial-trip propellers are practically unsuited for that draft, and the loss of speed which ensues consequent on the choking of the propellers due to increased draft and displacement, is noticeable, and gives some disappointment.

I am of opinion, however, that all 27-knot destroyers could even now obtain better sea-speeds if they could be fitted with propellers different from their original ones. But this is a very complicated question, as it will be seen that a propeller which may enable the engines to do their speed, we will say, of 400 revolutions a minute with a fully loaded destroyer, may let those engines run away in an undesirable manner if she be lightened to nearly empty bunkers and magazines. New deep-draft propellers provided by the original constructors of the vessels would doubtless give increased speed with lessened coal bills, which would soon pay for this small outlay.

Those 27-knot boats gave an indication that the depth of water in which measured mile trials were run was of very great moment in results obtained. Practically in the same vessel run on two different measured miles, one locality would require fewer revolutions per knot, and the engine not so much loaded as the other. In this respect there is no doubt the measured mile at Wemyss Bay is the best. Those destroyers which obtained their speed in

shallow water have generally given better sea results than those which obtained their speed in deep water.

Experience gained in the 27-knot destroyers was of great use when faster ones of 30-knot speed were required.

During the construction of the 27-knot destroyers Messrs. Yarrow & Company produced the *Sokol*, a destroyer for the Russian navy. This vessel, 190 feet long by 18 feet 6 inches beam, obtained a speed of 29¾ knots in the shallow water of the Maplin Sands measured mile, and so proved herself superior to all British destroyers. Probably if she had run at Wemyss Bay she would have approached 31 knots. She was the precursor and pattern of a large number constructed in Russian yards.

The terms of the trials for the 30-knot destroyers were very much amplified, for whereas in the former 27-knot destroyers there were no reserves of coal consumption, in these it was intended that 2½ pounds per indicated horsepower per hour should be a standard. This was much less than the average of the former 27-knot destroyers. Messrs. Thornycroft & Company obtained the first record for 30 knots in a British naval vessel at the Maplin Sands in the *Desperate* in April, 1896. The vessel was loaded as per contract, and ran this trial in a stiff gale with all wind resistances, boats, etc., in place. Various contractors throughout the kingdom followed on, and in most cases fulfilled the contract without very much exertion. There were, as before, a few incidents arising from unforeseen circumstances, but take it all round the 30-knot destroyer gave less trouble than prior ones.

Two other destroyers of higher speeds were also produced, the *Albatross* by Thornycroft, and the *Express* by Laird. The former obtained a speed of 31½ knots with indicted horsepower of 7,700. This was at the Maplin Sands, where the drag of water, due to shallowness, became very apparent. The latter was tried at Wemyss Bay.

The 30-knot destroyers were followed by a reaction in favor of stronger vessels, now known as the river class. These vessels are of about 550 tons displacement, 200 to 230 feet long, and horsepower 7,500. They are much more costly than the 30-knot destroyers, and though their speed of 25½ knots was obtained in deep water, I am of opinion that, as before mentioned in my remarks, if the 30-knot destroyers had different propellers fitted they would outrace all the rivers at war-service lading with a smaller coal bill.

The following table, taken from a parliamentary return, gives information of the river class:

TABLE 1.

River Class Destroyers	By whom built	Speed obtained on full speed trials Knots	Coal per I. H. P. on the high speed consumption trial Pounds per hour	Air pressure on full speed trial Inches
Welland	Yarrow & Co.	26.2	1.65	1.8
Usk	"	26.1	1.77	1.6
Teviot	"	25.9	2.07	2.0
Ribble	"	25.8	1.57	1.6
Exe	Palmer's Co.	25.6	2.11	2.4
Waveny	Hawthorn Leslie	25.6	2.19	3.2
Derwent	"	25.7	2.24	2.8
Erne	Palmer's Co.	25.6	2.25	2.5
Dee	"	25.5	2.28	2.6
Ettrick	"	25.6	2.33	2.6
Cherwell	"	25.6	2.34	2.7
Kennet	Thornycroft & Co.	26.0	2.39	3.8
Jed	"	25.7	2.46	4.0
Itchen	Laird Bros.	25.6	2.46	4.3
Blackwater	"	25.7	2.62	5.3
Arun	"	25.7	2.68	4.4
Foyle	"	25.6	2.79	4.4
Eden (turbine)	Hawthorn Leslie	26.2	tons cwt. 7 9 per hour	3.3

I should mention that the latest torpedo boats, Nos. 89 to 117, were tried at their deep-sea draft, and obtained speeds of 25 knots, with an average horsepower of about 3,000. These vessels are superior to earlier torpedo boats, and being 165½ feet long (about 9 beams), are good sea boats.

The newspapers tell us that a destroyer of 33 knots is again contemplated, and it will be apparent that very high power will be required. The following table will show that in the 20-knot

TABLE 2.

Vessel	Length Feet	Speed Knots	I. H. P. per ton of displacement	Propellers
Miranda	45½	16	14.7	Forged steel
Torpedo Boat	113	20	10.6	"
"	125	21	10.6	"
"	130	22	12.9	"
"	140	23	15.6	"
"	140	23	13.0	Manganese bronze
"	165½	25	15.0	"
River class Destroyer	220	25½	12.6	"
"	185	27	15.7	"
"	215	30	20.0	"
"	228	31½	21.1	"

boats of the eighties it required 10½ horsepower per ton of displacement, and so on through each batch of vessels as they became larger.

In conclusion, I may be permitted, perhaps, to express a few opinions as to the utility of these vessels. As I have said, they appeal to marine engineers, because the Whitehead is a marine engineer's invention and is a weapon which all marine engineers can well manipulate; and I think that if a Coast Volunteer Corps could be established, composed largely of young marine engineers, for service in these vessels as coast defenders, not only the manipulation of the machinery and of the Whitehead, but also the firing of the guns, could be intrusted to such volunteers, and the pure navigation of the ships and boat-work done by men of whom there are so many around our coasts as trawlers, fishermen, and others. I suggest that the whole of our coasts could be defended by torpedo boats and destroyers, leaving the battleships to do their work on the high seas.

It has been said that the war in the Far East has proved the utility of the battleship, and that only. But it must be remembered that Admiral Togo had to nurse his destroyers and do the greatest injury with the smallest risk, so that had he had more destroyers, and so been enabled to risk more, we might have heard a different account of the deadly weapon, the Whitehead.

At all events, I think that, say, 1,200 men would be better utilized in craft of the destroyer and torpedo-boat description than putting the same number in a large battleship, which might be sunk by even one of these craft; and we have very high authority stating that four such craft, costing a fourth the price, and manned by a fourth of the crew of a battleship, would doubtless sink that battleship. And surely they would prevent her approach to our shores near enough for her guns to range us. Moreover, torpedo boats and destroyers remain war-worthy longer than battleships.

In these days, when conscription is being preached, it is well to consider alternatives. Our thickly-inhabited islands have 3,740 miles of coast line. Allowing one destroyer or sea-going torpedo boat to each ten miles, we find that 200 destroyers and 174 torpedo boats, manned by twenty-one thousand sea-stomached young mechanical engineers and small-craft men, would give national mental repose at a cost of twenty millions sterling as a preliminary outlay and about two millions a year for wages and maintenance.

Is this as good as conscription? Would not young Britons prefer to serve in and be slaughtered in a destroyer rather than a battleship? Indirectly, our nation should gain by the technical education imbibed, both in constructing this Ban Dog fleet and also in service therein. "'Ware the Ban Dog," so long potent in our island life, would suggest a motto for such a corps—W. T. B. D.

A SURVEY OF SCOTCH SHIPBUILDING IN 1905.

BY BENJAMIN TAYLOR.

When reporting to Marine Engineering a year ago on shipbuilding in Scotland in 1904, I said that while that had not been a record year the output of the Scotch yards had turned out greater than was anticipated. The output of 1905 has, however, been a record. It amounted to 587,930 tons, and is one-third of the production of the United Kingdom, and one-fifth of the estimated production of the world. It has not been a year of any remarkable sensation in shipbuilding, although the yards have yielded some monsters, but it has been a year of striking developments which merit some consideration here.

In the world's output the lead is still held by the United Kingdom. There have been increases of output in most of the shipbuilding countries of the world, but the increase in the United Kingdom is most marked. British yards in 1905 built, in excess of 1904, 112 vessels of 429,838 tons and 162,887 indicated horsepower. This addition is more than the whole production of either Germany or the United States, and yet the yards were not operated up to their full capacity. In time of real pressure they could add as much to the 1905 output as they that year added to the output of 1904. There were increases on the Tyne, the Wear, the Tees, and Hartlepool, Barrow-in-Furness, the Humber, and the English Channel; in the United States, Germany, Holland, Japan, Russia, Denmark, Sweden and Spain; but there were decreases on the Thames, the Bristol Channel, and in France, Italy, Norway, Austria-Hungary, China, and Belgium.

The Clyde has for the third time launched within twelve months an aggregate of over half a million tons. Prior to 1901 the annual figures ran generally between 300,000 and 400,000 tons. After the depression of the "eighties" shipbuilding made steady progress, always gaining more ground than it lost. In 1901 the half-million ton mark was turned; in 1902 there was further progress; in 1903 and 1904 dull trade gave the figures a set-back; but now the lost ground has been more than regained. In 1905 319 vessels of 539,850 tons were launched here, 121,980 tons more than the output of 1904, and 22,873 tons more than that of 1902, the previous record year. Russell & Company, Port-Glasgow, are again the builders of the largest tonnage on the Clyde for the year. In 1904 they were highest, not only on the Clyde, but in the whole world. After them on the Clyde come Charles Connell & Co. Barclay, Curle & Co., Limited, who were third in 1904, are now fourth, and the Fairfield Company are now third. D. & W. Henderson & Co. have a larger tonnage than they had last year, and are fifth.

Among vessels built on the Clyde in 1905 precedence must certainly be given to the Cunard turbine steamer *Carmania*,* which was the largest vessel launched on the river, and the most interesting launched in the world. Other turbine steamers launched on the Clyde were the *Maheno*† at Dumbarton, for New Zealand; the *Dieppe*** at Fairfield and the *Onward* and *Invicta* at Dumbarton,—all three for English Channel service. Other large vessels were the Fairfield Canadian Pacific steamer *Empress of Britain*††, the Hamburg-American liner *Fuerst Bismarck*, also built at Fairfield; three P. & O. liners built at Caird & Co's, and the two P. & O. liners *Dongola*§ and *Peshawur* built at Barclay, Curle & Co's. Only one warship is in the list of Clyde launches, H. M. S. *Cochrane*§§, built at Fairfield. In all the 319 launches there was only one sailing vessel, though in 1904 half a dozen sailers were included. The following table shows the types of vessels which compose the Clyde tonnage of 1905:

TYPE	NO.	TONNAGE	MEAN
Screw steamers	165	389,064	2,358
Twin screw steamers	21	76,648	3,650
Turbines	5	29,444	5,889
Warships	1	13,550	13,550
Dredgers	25	12,851	514
Barges and lighters	30	6,863	229
Paddle steamers	14	2,656	190
Sailing vessels	1	2,430	2,430
Fishing vessels	12	2,356	196
Tugs	19	1,935	102
Yachts	14	1,050	75
Sternwheel steamers	9	968	108
Launches	3	35	12
	319	539,850	1,693

While in 1904 the Clyde produced five of the six largest vessels built in the world, in 1905 the Clyde has only three of the largest. Harland & Wolff, Belfast, had two, and the Vulcan Company of Stettin had one. Two Hamburg-American liners exceeded in size the *Carmania*. The 1904 average of large vessels was 11,769 tons for six vessels; in 1905 the average was 18,090. The leading vessels built in Europe, measured by tonnage, and excluding warships, are:

VESSEL	GROSS TONS	BUILDERS
Kaiserin Auguste Victoria	25,000	Vulcan Co., Stettin
Amerika†	22,724	Harland & Wolff, Belfast
Carmania	19,594	John Brown & Co., Clyde
Nieuw Amsterdam	17,250	Harland & Wolff, Belfast
Empress of Britain	14,530	Fairfield S. & E. Co., Clyde
Mooltan	9,621	Caird & Co., Clyde

There were fewer turbine vessels launched in 1905 than in 1904, but there are a large number now on order. The 1905 turbines are:

VESSEL	GROSS TONS	BUILT AT	FOR
Dieppe	1,217	Govan, Clyde	Newhaven
Maheno	5,282	Dumbarton, Clyde	New Zealand
Onward	1,671	Dumbarton, Clyde	London
Invicta	1,680	Dumbarton, Clyde	London
Carmania	19,594	Clydebank, Clyde	Cunard Company
Viking	1,951	Newcastle, Tyne	Isle of Man
Bingera	2,090	Belfast	Glasgow
Kaiser	1,916	Stettin	Hamburg

The Allan turbine liner *Virginian** was the first of the ocean-going turbine steamers—length 540 feet, and 13,000 tons displacement, equivalent horsepower 12,000, with three shafts running at 275 revolutions. The trial speed was 19.5 knots. This ship was built by Workman, Clark & Co., Belfast, and her sister the *Victorian*, by A. Stephen & Sons, Clyde. H. M. S. *Amethyst*§, a turbine cruiser of the British Navy, 360 feet long and 3,000 tons displacement, was built in 1904 and delivered in 1905. She was the immediate cause of the Admiralty's adopting the Parsons turbine for all the designs issued during 1905. Built by the Armstrong Company, on her full power trial she ran at 23.6 knots, as against 22 knots of her sister ship *Topaze*, showing that with the same steam capacity turbines can exert a power 40 percent greater than reciprocating machinery. The Clyde steamers *King Edward*** and *Queen Alexandra* of 1901 and 1902, were the pioneers of turbine passenger steamers, and now there is a long list of fast channel steamers using the Parsons turbine; but

*See page 1, Marine Engineering, January, 1906.
†See page 489, Marine Engineering, December, 1905.
**See page 247, Marine Engineering, June, 1905.
††See page 16, Marine Engineering, January, 1906.
§See page 46, Marine Engineering, February, 1906.
§§See page 295, Marine Engineering, July, 1905.

†See page 483, Marine Engineering, December, 1905.
*See page 359, Marine Engineering, September, 1905.
§See page 37, Marine Engineering, January, 1905.
**See page 395, Marine Engineering, September, 1901; also page 8, January, 1902.

uncertainty has existed as to the power likely to be developed, and the speed to be realized.

The *Viking**, on the service between the Isle of Man and Liverpool, was built by the Armstrong-Whitworth Co., for the Isle of Man Steam Packet Company. The service speed guaranteed was 22 knots, and on her trial the ship ran for 140 miles at a mean speed of 23.5 knots. She is 361 feet long and 42 feet broad, with a shelter deck and a long promenade deck to accommodate an enormous number of passengers.

The turbine yacht *Albion* was designed by Sir William H. White for Sir George Newnes, and was built by Swan, Hunter & Wigham Richardson, Tyne. She is 270 feet long, 34 feet beam, and of 1,250 tons (Thames Yacht measurement). Her speed is 15 knots, for which turbine machinery of 1,800 equivalent horsepower is provided, there being three screws, one on each shaft. She carries enough coal to go around the world under her own steam. All the auxiliary machinery is worked by electricity, and she is as free from vibration as a sailing vessel.

The *Carmania* has been already fully described in these pages. Her dimensions are 650 feet length, 72 feet breadth, 33 feet 3 inches draught for 30,918 tons displacement. She was built to Admiralty requirements as to subdivision and protection under water of her steering gear and rudder, and is liable to be taken up by the government as an auxiliary cruiser. Her main interest is the adoption of Parsons' turbine machinery, being fully a knot faster than her sister ship *Caronia*, fitted with reciprocating machinery. The *Carmania*, with a foul bottom, realized on her trial trip 20 knots, and with a clean bottom is good for 20.5 knots, a speed more than the owners required.

The *Empress of Britain* and her sister ship *Empress of Ireland* are the latest ship enterprises of the Canadian Pacific Railway Company. These splendid passenger steamers are to run between Liverpool and Quebec. The dimensions are: 570 feet over all, 65 feet 6 inches breadth; gross tonnage, 14,500; displacement about 20,000 tons. The ships are held by some to represent the last word of the marine engineer in respect to reciprocating machinery for Atlantic liners. On their regular service they are expected to do the trip in a week. Each ship will carry 310 first-class, 470 second-class, 500 third-class passengers, on or above the main deck, and 270 steerage passengers on the lower deck forward. The builders are the Fairfield Company, Glasgow.

Shipbuilding designs are changing faster than they did formerly, and ships now become obsolete more frequently by getting out of date than by age. The building of single deck cargo steamers displaces vessels of older types while the intermediate liner carrying passengers with a large amount of cargo is affecting the purely cargo steamer. The cargo boat must, therefore, be specialized in every possible way. In grain, ore and coal carriers the design is to facilitate loading and discharging, and the necessity for quick dispatch has evolved the self-trimmer and the beamless turret. As these types come in the older types are sold to foreigners, and this process of conversion accounts for a large proportion of the recent boom. It is commonly said that the day of the sailing ship is coming to an end, but in certain trades the big sailer will hold her own. Still, the building of sailing ships was certainly never at a lower point, and even in France, in spite of bounties, there is now hardly anything built but steamers.

An interesting type of cargo vessel is the *Christian Knudsen*, launched during the past year by Sir Raylton Dixon & Co., of Middlesborough. She is built with holds free from any obstructions of beams, pillars, web frames or side stringers, by the use of cantilever framing, and top-side water-ballast tanks. The hold is thus adapted to the self-trimming of cargo without loss of stowage. The tanks under the deck are employed for ballast, together with the double bottom, and proper immersion is given for seaworthiness. She behaves well at sea, not shipping any water even in the heaviest weather on the Atlantic. She has large hatchways, 70 feet by 30 feet, and carries nearly 7,000 tons of coal, which can be discharged in seven hours without any "trimmers."

The conditions of shipowning make now for standardization, as builders' records show. Standardization was in evidence when sailers were being turned out rapidly; and among builders of trawlers standardization has been constant for some time. The standards now in evidence are:-Spar deck, 344 feet by 49 feet by 17 feet 9 inches; also 330 feet 9 inches by 45 feet 6 inches, by 16 feet 2 inches; and of both of these quite a number of vessels have been built. Single deck steamer types are 340 feet by 48 feet by 25 feet 9 inches; and 331 feet by 47 feet by 24 feet 8 inches, of both of which also a large number has been built. The size has been increasing, and single-deck steamers 345 feet by 49 feet 9 inches by 28 feet 5 inches have recently been favorites; also a larger type, 370 feet by 49 feet 9 inches by 29 feet 8 inches. Some owners, for the same length, have two feet more beam and a foot less depth, giving a vessel capable of lifting 7,100 tons on a draft of 22 feet 6 inches. Of these standard types nearly 150 steamers have been built in the Scottish and English yards. This refers to tramps, but standardization is adopted in other branches of structural engineering, and it would seem that the yards that standardize most are the yards that will do the most business.

The case of Wm. Doxford & Sons, Limited, is one in point. The year 1905 has been a record year on the Wear, and to this result the above firm have materially contributed. During the course of the year they launched twenty of their "turret" steamers of a total of 86,632 tons. They are not only first on the Wear list, but they have this year the largest tonnage for any single firm in the world. Three of the largest "turret" steamers in the world—vessels of 7,700 tons register—are among their products. Messrs. Doxfords' success must be attributed to standardization,—to specialization in a type that is economical in structure, in working and in carrying capacity.

The building of steam trawlers is another specialty in which standardization tells. These vessels are turned out in large numbers at Hull, Yarmouth, North and South Shields, Aberdeen and Glasgow by firms who specialize in this class of work. The conversion of the fleets of sail fishing boats into trawlers, drifters and fleeters has given a great deal of work to these builders, and new markets for steam fishing vessels are being found. Newfoundland, South Africa, and Australia are all developing their fisheries by acquiring steam trawlers of large size and good speed, and various British firms have executed contracts for these colonies. Several large trawlers have been built by Mackie & Thompson, Glasgow, for French owners; while Smith's Dock Company, North Shields, have built four large trawlers for French owners for use on the Newfoundland coast. The John Duthie Company, Aberdeen, have built a trawler of 300 tons, also for France.

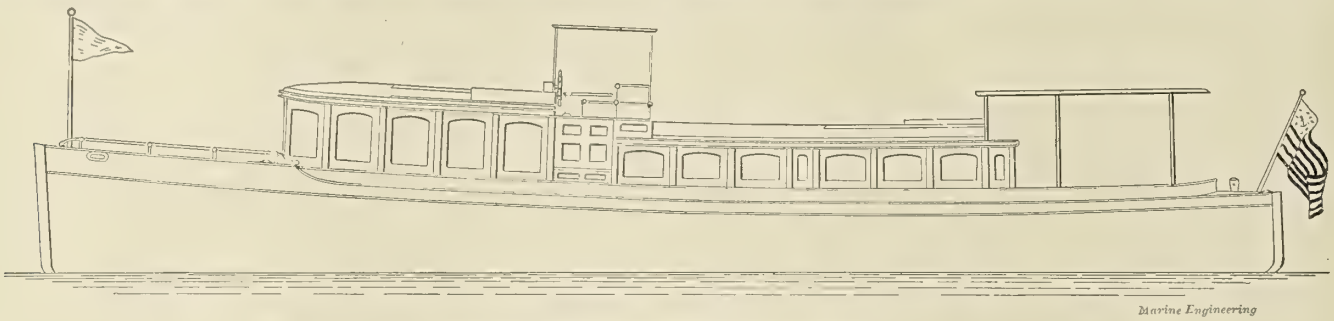
The reciprocating engine has been practically abandoned for certain classes of ships, and engineers are now turning fresh attention to the boiler, and even dream of a turbine ship without boilers. The gas turbine may bring this within the range of practical engineering.

The use of the petrol (gasoline) engine for marine work is increasing, and for certain work there is an enormous field for it. The gas engine with plant for producer gas is in operation for land work up to 5,000 indicated horsepower; but there are certain disadvantages in its use for large marine work, such as lack of easily worked reversing power. Sir William White said recently at the Motor Show at the Crystal Palace, London, that "taking the latest types of steam machines and comparing them with the explosion engine, the internal combustion motor and its fuel gives equal speed and equal range of action to a steam engine—with boiler, water and fuel of six times the weight." The question is whether the explosive engine of the motor car

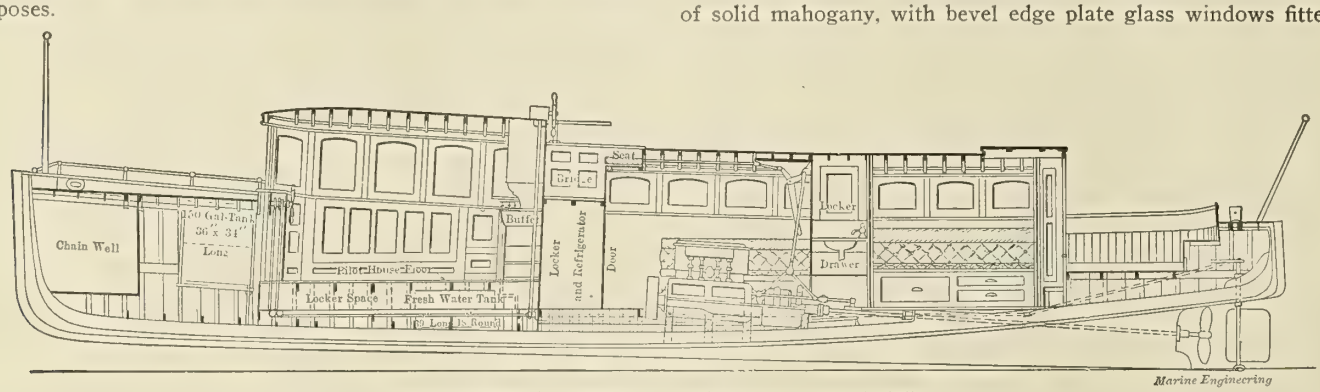
*See page 443, Marine Engineering, November, 1905.

contains within itself the germ of the power to propel ships better than they are at present propelled by steam. Engineers are looking towards the gas motor as the germ of the engine of the future. Already Thornycroft & Co. have turned out a gas-producer motor boat, which has run trials at Southampton. William Beardmore & Company, Clyde, have the British rights in the Capitaine gas engine, and they are re-engining a steamer, *The Earl,* by substituting for the boiler and reciprocating engine a Capitaine gas engine, intended to develop 600 horsepower. The result of this experiment will be looked forward to with great interest.

The motor boat *Napier Major* was the center of attraction at the recent motor exhibition in London. Her dimensions are 45 feet by 8 feet 6 inches by 5 feet 6 inches depth. Her engine is a 24 horsepower 4-cylinder Napier, giving a speed of about 8 knots. She is a fine sea boat, and is rigged so that in case of necessity she could sail into port. Seven people can be accommodated on board. She has traversed 6,000 miles of sea in six months and performed a non-stop run of 650 miles in 5 days and nights. The *Iris,* of Southampton, 30 feet in length, was run from Southampton to Gravesend without a stop. In fact the day of the motor boat has come; and we now await the advent of the gas-producing self-propelling motor ship for ocean carrying purposes.



OUTWARD PROFILE OF CRUISING LAUNCH ANITA.



INBOARD PROFILE, SHOWING ARRANGEMENT OF COMPARTMENTS.

THE FIFTY-ONE FOOT CRUISING LAUNCH ANITA.

The launch of which we present illustrations has been built by the Matthews Boat Company, of Bascom, Ohio. The length over all is 51 feet 1½ inches; the extreme beam, 10 feet 4 inches; extreme draft, 34 inches, and freeboard forward 3 feet 2½ inches. In general arrangement, the length is divided into a forward deck, 10 feet in length, a pilot house 11 feet 4 inches, a cabin consisting of an extension aft of the pilot house and with a length of 18 feet 9 inches, and a short open cockpit at the rear. The pilot house is fitted with two pullman berths with a width of about 36 inches, the interior finish of the entire house being raised panel work in mahogany. This pilot house has further a folding mahogany table and a staircase leading to the bridge, which is situated immediately abaft of the pilot house on top of the forward end of the cabin. There are also a mahogany buffet and wardrobe with plate glass panels and suitable arrangement of drawers, lockers, etc.

The engine room is in the forward part of the cabin, and is furnished in the same manner as the pilot house, having on the port side a sliding berth for the engineer and on the starboard side pullman folding berths. Under these is space for lockers and cupboards for stowage of supplies. The galley is fitted with a kerosene stove and a sink, together with a fresh water tank in the floor with a capacity of sixty gallons and connected with a nickel plated pump; a zinc-lined refrigerator, dish rack and glass rack, and a ventilator in the roof to carry off the odor of the cooking. The floor is covered with linoleum, and all the hardware is of polished brass. A toilet room and lavatory is fitted just aft of the engine room, and measures 2 feet 6 inches by 4 feet 5 inches.

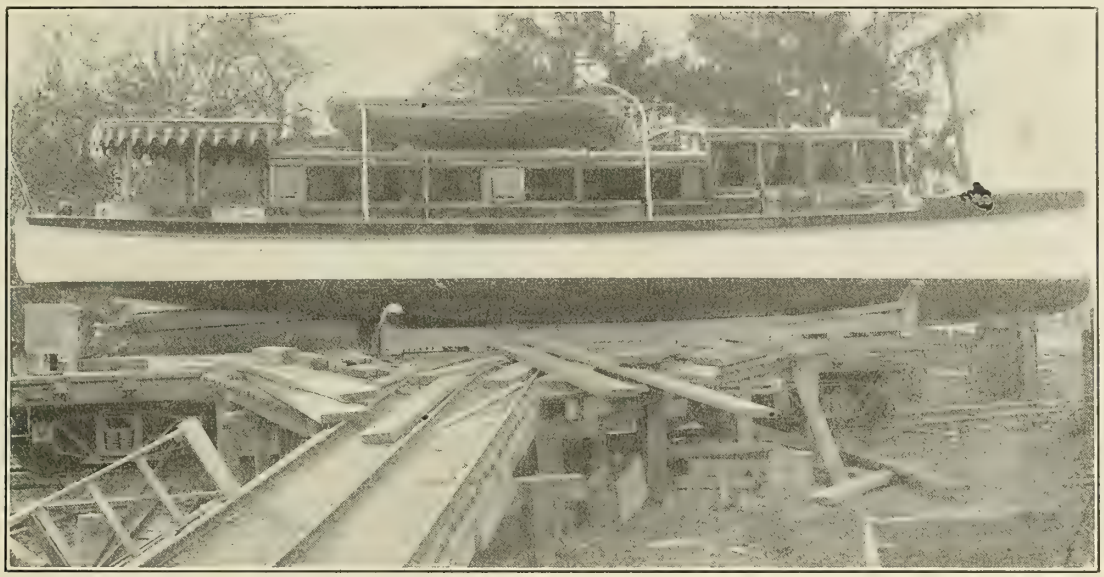
The after part of the cabin is fitted with broad davenports on each side, being of an extension berth pattern 36½ inches in and cupboards for stowage of supplies. The galley is fitted on each side one large and two small drawers. At the rear end are full length wardrobes fitted with shelves and brass hooks. A sliding hatch in the companionway affords exit from the cabin to the rear cockpit. The latter is open, with a stationary canopy top supported by turned stanchions, and is finished inside and out with solid mahogany, together with a mahogany coaming; the floor covering is of inlaid linoleum, and cushions of fabrikoid cork. The finish throughout the cabin both inside and out is of solid mahogany, with bevel edge plate glass windows fitted to drop into pockets, and with brass locks and lifts. The windows of the pilot house and saloon are fitted with curtains matching in general coloring the upholstering, and the floors are covered with wilton carpets of the same general color scheme.

The construction of the hull includes keel timbers of white oak 2⅞ inches thick, in widths of from 12 to 19 inches, all joints being laid in white lead and fastened with bronze bolts; the scarfs or joints have a length in each case of not less than 54 inches. There are sister keelsons bolted to the keel, and constructed of white oak 2¼ by 5¼ inches, with proper notches to receive the ends of frames, the main keel being rabbetted to receive the outside planking. The shaft log is of white oak 6 by 8 inches in section. The frames are of white oak 1½ by 1¾ inches, steam bent, and spaced 9 inches between centers except over the 12 feet of the engine compartment, where the spacing is 5 inches. Sheer strake is of mahogany 1⅜ inches thick and varying in width from 5 to 7 inches. A mahogany bulwark is fitted on the forward deck, 7¼ inches high at the stem and 8½

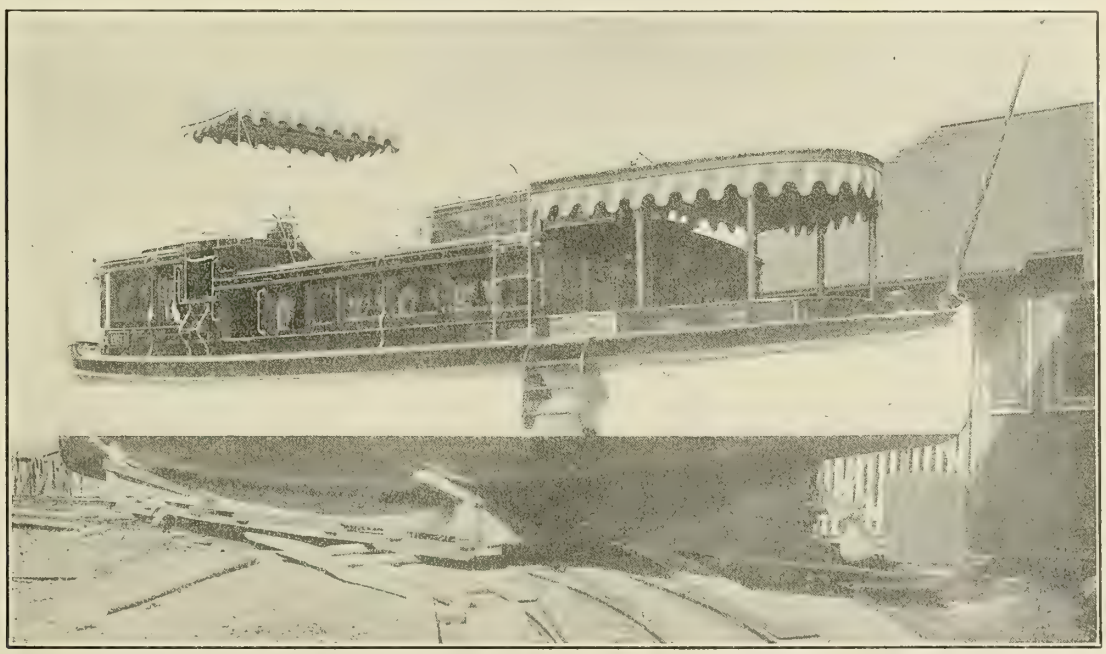
inches above the deck at the rear end, the length being 14 feet. These measurements include the height of the rail, which is of white oak 3½ inches wide and 1¼ thick. The bulwark is supported by heavy oak extensions to the frames. The deck is of white oak fitted in strips 1 by 1¾ inches, with seams thoroughly calked. The outside planking is of cedar, tapering in thickness from 1¾ inches at the garboard strake to 1⅜ at the sheer, the garboard strake itself being of white oak 1¾ inches thick. All the planking is secured to the frames by riveted copper nails, all butts being reinforced with white oak blocks. The engine timbers measure 3 by 7 inches in section and are 14 feet long, extending fore and aft on either side of the keel and securely fastened to same; thwartship oak timbers 3 inches thick being fitted to support the engine. The engine and fly wheel pits are lined with sheet brass for the purpose of excluding water and collecting oil.

A gasoline tank is fitted forward under the open deck, with a capacity of 150 gallons. It is constructed of heavy rolled copper, copper riveted, and is suitably provided with ventilating device. The pipe leading to the engine is of seamless brass tubing, with all joints threaded and then tinned. It runs inside the hull, passing through the water tight bulkhead at the forward end of the pilot house. There is also provided under the forward deck a chain locker with suitable hawser pipe on deck and a small horizontal capstan operated by hand. Two steering wheels are provided, one being a large mahogany wheel with brass trimmings in the pilot house, and fitted in a handsome binnacle stand, while the other, which is of solid brass, is located on the bridge, and has a diameter of 21 inches. The steering cable of phosphor bronze, which passes through suitable blocks and guides, has a diameter of ⅜ inch. The tiller is of bronze of a compensating arc type with rudder and rudder post of tobin bronze. A skeg of this same material, measuring 1⅛ by 2 inches, supports the lower end of the rudder post.

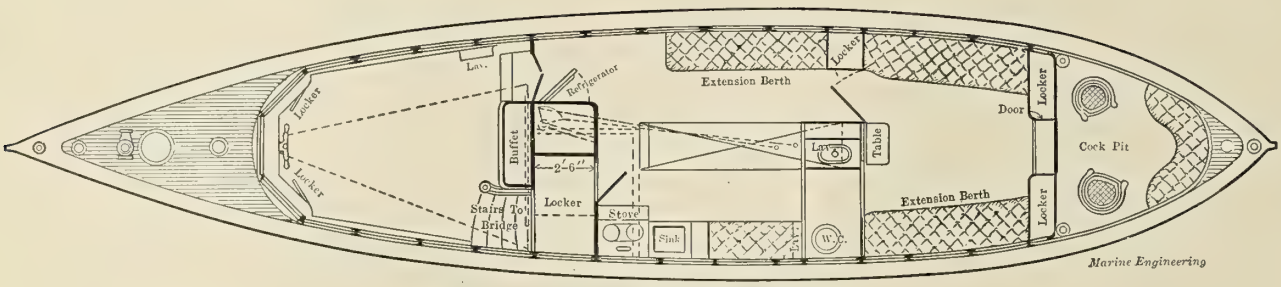
There are fitted a small Carlisle-Finch searchlight, with a dynamo connected to the engine, and storage batteries for use when the engine is not running. Electric lights are fitted



STARBOARD SIDE OF ANITA, READY FOR SHIPMENT.



QUARTER STERN VIEW, SHOWING THREE-BLADED PROPELLER.

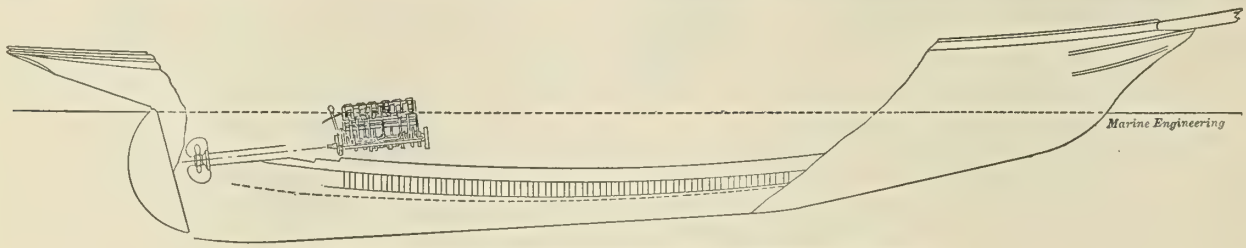


GENERAL ARRANGEMENT PLAN OF LAUNCH ANITA.

throughout the hull, there being one ceiling fixture and one wall fixture in the pilot house, with opal globes; a wall fixture and a switchboard fixture in the engine room; lamps in galleys and toilet room; a ceiling fixture and two side wall fixtures in the saloon.

An Auxiliary Fishing Schooner.

The largest fishing schooner on the New England coast is the *Elizabeth Silsbee,* of which we are enabled to present herewith photograph and sail plan, as well as a photograph of the engine and view showing its position in the ship. The *Silsbee*

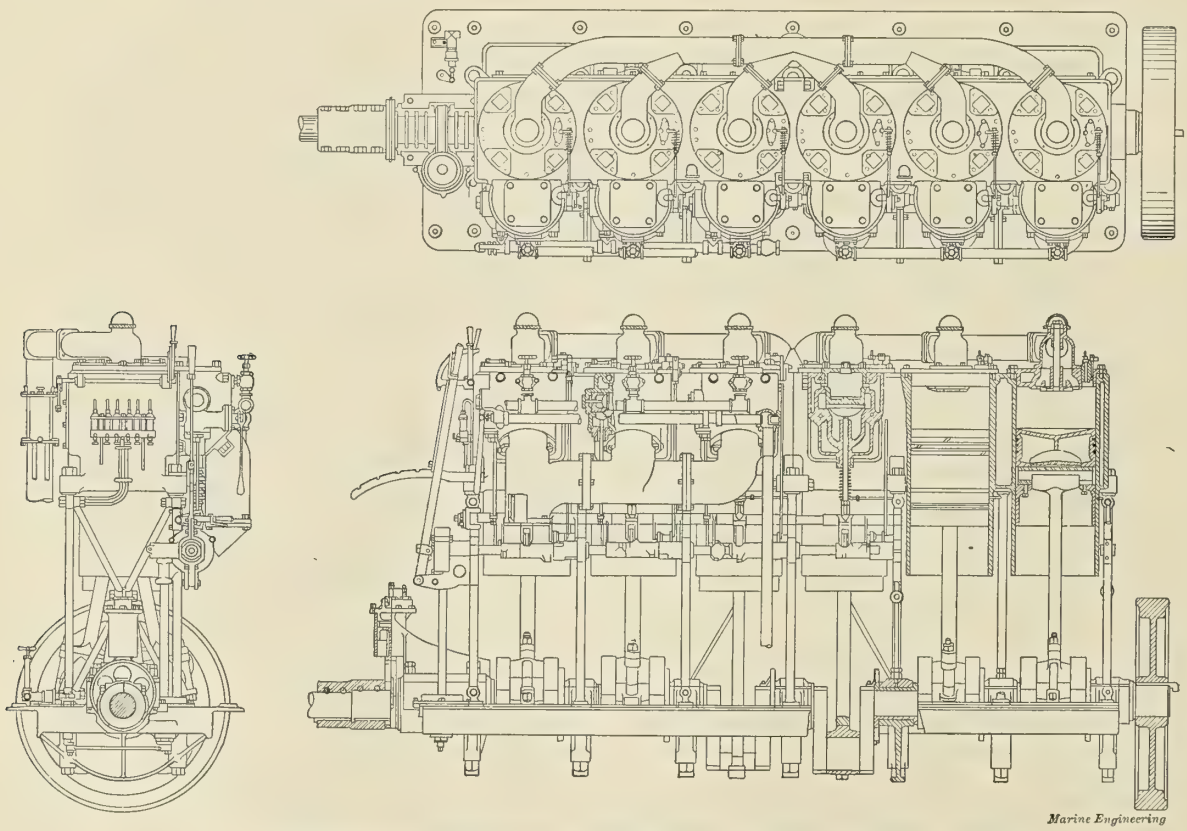


SKETCH OF SILSBEE, SHOWING LOCATION OF 300-HORSEPOWER ENGINE.

The equipment further provides a pair of galvanized steel davits and blocks for hoisting the anchors; a pair of boarding steps; the usual flagpoles and ropes; fenders; buoys and lines; and an anchor weighing 100 pounds, with 160 feet of rope. There have also been provided a mahogany finished 12-foot yacht tender for propulsion by oars, and appropriate galvanized steel davits with lignum vitæ blocks for hoisting the tender to the roof of the cabin.

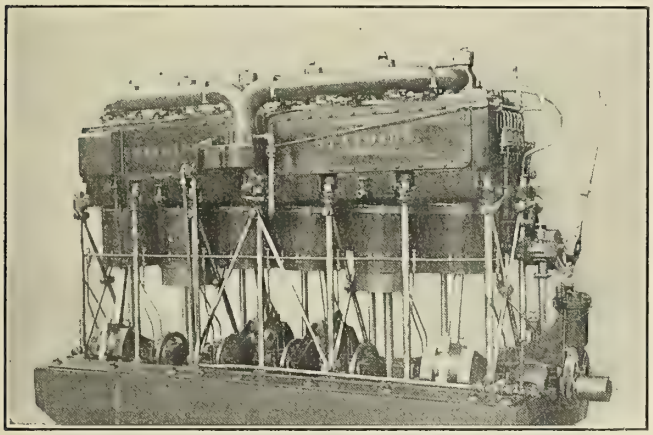
has a length of 134 feet over all, 103 feet on the water line, a beam of 25 feet and a draft 13 feet 6 inches. The bowsprit has a length of 32 feet outboard, the foremast and mainmast heights above deck of 65 and 77 feet respectively, the fore and main topmasts lengths of 45 and 52 feet, the main boom 75 feet and the main gaff 50 feet. The dimensions of the several sails are well shown in the sail plan presented.

The schooner has been fitted with a 300-horsepower gasoline



PLAN AND ELEVATIONS OF 300-HORSEPOWER STANDARD ENGINE, AS FITTED TO ELIZABETH SILSBEE.

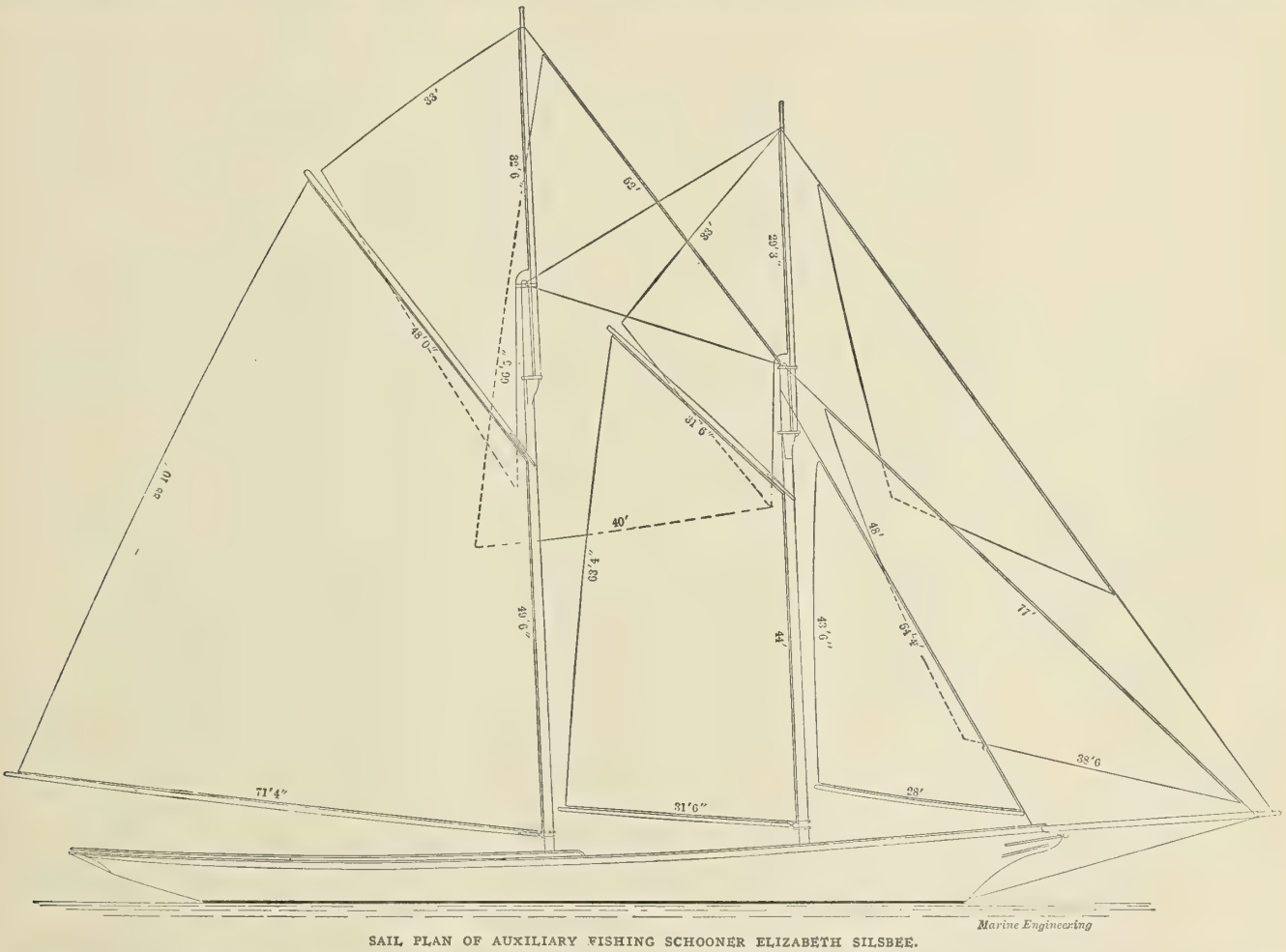
engine of the reversing type, built by the Standard Motor Construction Company of Jersey City, and having six cylinders measuring 12 inches diameter by 14 inches stroke. The reverse arrangement is said to be as positive as the reversing gear on a steam outfit. The propeller is coupled direct to the engine and



REVERSING ENGINE OF SILSBEE.

THE SILSBEE UNDER SAIL.

is started instantly by shifting the valve motion to the desired position, there being no dead centers. The reversing mechanism is not of the haphazard type in which the operation is obtained by advancing the spark and tripping same to cause the engine to kick back, but is of such a nature that it can be started from a cold engine. The valve motion is shifted from a central point to the forward or reverse position, and the engine started by means of compressed air. As soon as the engine is turning over smoothly, the air supply is shut off and recourse had to power derived from the gasoline in the regular way. The air tank is of sufficient capacity to cover twenty or thirty starts, and is kept replenished by a small air pump attached to the engine.



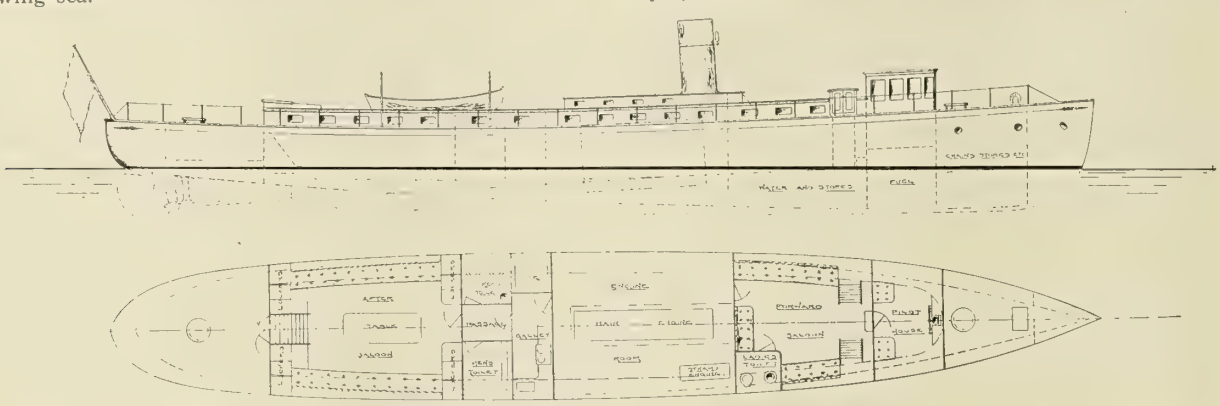
SAIL PLAN OF AUXILIARY FISHING SCHOONER ELIZABETH SILSBEE.

The *Silsbee* is stated to be not only the fastest fishing schooner

under sail, but also the fastest under power. With the machinery fitted she has no difficulty in making twelve knots, and when to the power of the engine is added a good whole sail breeze, it is not unusual for her to reel off sixteen knots for hours at a time. Two or three more boats of the same type are under construction. We are indebted for information regarding the *Silsbee* to Burgess & Packard of Boston, who superintended her refit.

A NEW MOTOR FISHING BOAT.

The accompanying cuts show the general arrangement and lines of a motor boat, being built at the works of the Electric Launch Co. of Bayonne, N. J., from the designs of N. C. Cushing, of New Rochelle, N. Y. The boat is intended for carrying fishing parties on daily excursions to various points along the New Jersey coast. The maximum carrying capacity is to be one hundred passengers, and the speed is to be 18 miles per hour. There are consequently no sleeping accommodations for passengers and the hull is so designed that speed, seaworthiness and carrying capacity have been given like consideration. The flare of the fore body should keep the boat very dry in a head sea, and the stern is so formed that the boat will lie easily in a following sea.



PROFILE AND ACCOMMODATION PLAN OF MOTOR FISHING BOAT.

The underbody is cut away in as easy a line as possible from stem to stern, to assist the speed, but the lines are kept very full aft to prevent squatting as much as possible when under full speed. The dead wood is carried well aft to insure the boat steering easily in a following sea, and in addition it lessens the rolling tendency and protects the shafting.

The engine is to be a six-cylinder, double-acting motor of 500 horsepower, of the latest type, built by the Standard Motor Construction Co. of Jersey City.

This is the highest powered single gas engine ever put into a boat, and is sufficient to give the five feet diameter propeller three hundred revolutions per minute. The exhaust will be carried up through the stack, which is shown on the plan.

The arrangement of the boat is very simple but sufficient in every way to satisfy the comfort of the passengers. The after saloon is 19 feet long, with a large centre table, and settees along either side. At the forward and aft ends of this saloon are 48 lockers for the storing of fish baskets and gear. Forward of the saloon, on either side of the passage leading into the galley, are the men's toilets. The galley extends for the full width of the boat, and is fitted with stove, sink, ice-box and the necessary shelves and lockers.

Forward of the galley is the large and airy engine room, 18½ feet long, containing the main engine, pumps, air-starting tanks and the dynamo, which is to furnish electric lights to all parts of the boat. The berths for the engineers will be situated on the port side of the engine room.

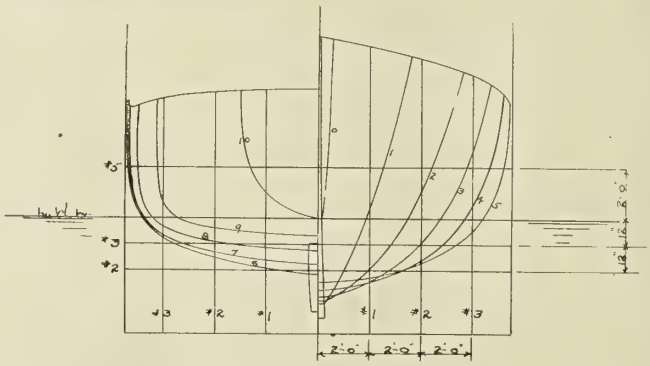
Directly forward of the engine room is the forward saloon, 14 feet long, with settees on either side, and the ladies' toilet on the starboard side in the after end. In the forward end on either side of the saloon is a companion leading up to the main deck. The pilot house, which is 7 feet in length, is forward of the saloon as shown, and is fitted with steering wheel, compass and overhead chart racks. Forward of the pilot house and below the main deck is the electric windlass for handling the anchor. The anchor chains and other stores will also be in this compartment, which is entered by a hatch in the main deck.

The tanks for the fuel will be under the pilot house, and those for water will be under the forward saloon. There will be one thousand gallons capacity of fuel, and five hundred gallons capacity for water, in the tanks.

The trunk of the cabin is 20 inches high and is 24 inches in from the side of the boat. These dimensions are to enable the passengers to sit comfortably on the trunk and fish over the hand rail, which extends all fore and aft.

The keel is of white oak, and is tapered in width at the bottom from 6 inches at the foot of the stem to 8½ inches at the after end. The frames will be of white oak 2½ inches by 3 inches and will be spaced at 12-inch intervals, and connected at the bottom by oak floors. The beams throughout will be of white oak, those for the main deck being 3 by 1¾ inches, and for the lower deck, 2 by 1½ inches.

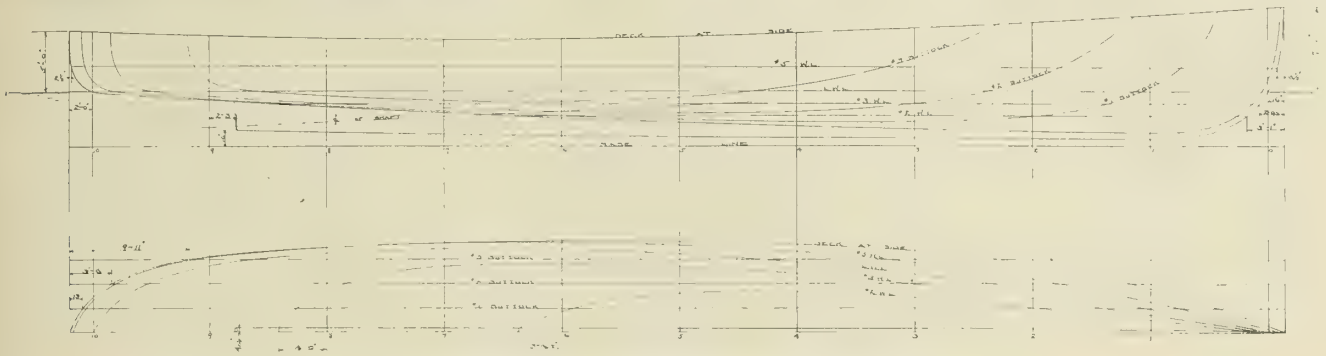
The engine foundation will be of yellow pine and will be formed by two longitudinal built-up girders extending well forward and aft of the engine bed. In addition the floors in way of the engine will be of extra depth and thickness. The bilge stringers on either side will be of yellow pine 4 by 6 inches, and will extend all fore and aft.



THE BODY PLAN

The hull planking throughout will be of yellow pine 1⅜ inches thick. The plankshear will also be of yellow pine, 6 inches by 2 inches. Directly under the plankshear and extending the full length of the boat is a fender of white oak 3½ by 3 inches for the protection of the planking in the many dock landings which will have to be made. The main deck will be of white oak 1⅜ inches thick. The sides of the deck house will be white oak, fitted as shown with sliding windows, which will

be protected by brass rods. The pilot house will also be of white oak, and will be raised sufficiently to give the pilot an unobstructed view in every direction. The lower deck will be white pine ⅞ inch thick, tongue and groove. There will be five watertight bulkheads of 1¾ inches white pine.



WATER LINES, AND BOW AND BUTTOCK LINES OF MOTOR FISHING BOAT.

The boat will be equipped with a life raft, boats, life preservers and all other fittings which can in any way promote the comfort and safety of the passengers. The boat is to be delivered in May in order to be in service during the coming season.

Speed of Sailing Vessels.

Editor, Marine Engineering:—

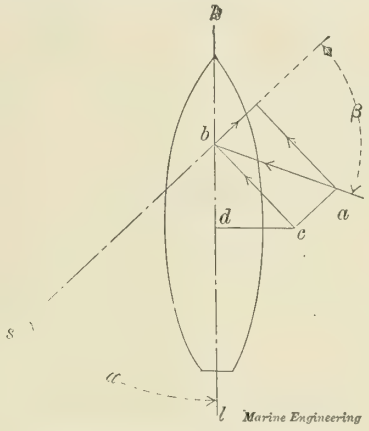
Do sailing vessels sail faster than the velocity of the wind propelling them?

Several months ago there appeared in the New York *Times* an article in which, among other things, was explained how a boat could, and often did, sail faster than the wind propelling it. The explanation given was substantially as follows: If a ball is placed on a billiard table and is urged forward with the cue, it will be seen that the ball travels at the same rate as the cue, but if a groove is cut in the table diagonally, so that the ball is forced to travel in it, then when the cue is moved across the table as before, the ball will travel much faster than the cue, and this is what occurs in the sail boat.

It would seem that there is a very apparent fallacy in this explanation, in that the magnitude of the forces required to move the ball in the two cases is entirely neglected. This brings us to the question: Do sailing vessels ever move faster than the wind propelling them? The answer seems to the writer to be *no,* under *any* circumstances. The result is apparent when looked at from a mathematical or from a common sense point of view.

Considering first the latter view. What makes the boat move through the water? It is the pressure of the wind on the sails. Now the wind's pressure is a direct result of its velocity, and the moving of a vessel in one direction or another, with relation to the wind, does not change the latter's velocity, and hence does not increase its force. It is well known that when the speed of a moving body is increased it takes more power to keep it going, whether it be through a system of gearing, of pulleys, or levers. Therefore, since a vessel can get no more force out of the wind than that due to its velocity it cannot sail faster than if floating in the air and traveling at the same speed as the wind. Again, if the vessel travels faster than the wind, we are getting something for nothing, and the result is "perpetual motion."

Now consider the problem from a mathematical standpoint. In this case, let us assume the best possible conditions, that is, with a sail which is perfectly flat. Let *Kl* of the accompanying figure represent the keel of the boat, *sb* the sail, *ab* the direction and magnitude of the wind, α the angle that the sail makes with the keel, and β the angle that the direction of the wind makes with the sail. Then, by resolving the force of the wind into its two components, one parallel and one perpendicular to the sail, we find that the latter, the effective one, $= ab \sin \beta$ But only a portion of this component is instrumental in driving the boat ahead, that represented by $bd = bc \times \sin \alpha = ab \times \sin \times \sin \alpha$. This, it will be seen, is a comparatively small portion of the original force *ab,* when a vessel is sailing as in the figure, or about as explained with the billiard table. The above expression will be seen to be a maximum when both α and $\beta = 90°$, the full force of the wind being then available. When a vessel is sailing across the wind its own velocity slightly augments the force of the wind, for in this case the sail is running against



THE RESOLUTION OF WIND PRESSURES.

the wind. From the above expression it is also seen that as α (and consequently β) diminishes, the value of *bd* diminishes, whereas in the billiard table illustration *bd* should increase. When α and β each $= 45°$ (the position in which some boats work the best) the value of *bd* is only one-half of the total force of the wind.

The deduction made, therefore, from the foregoing is that no sailing vessel ever travels faster than the wind propelling it.

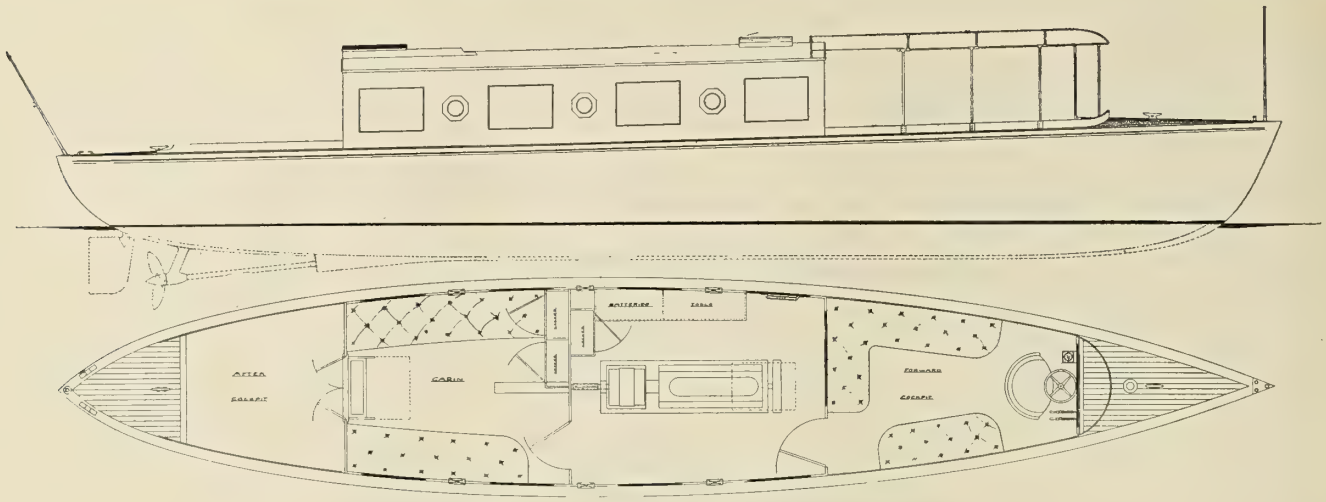
If anyone has made actual measurements to disprove the above conclusions, the result would be most interesting and instructive.

W. S. Fanning.

Obituary.

Capt. John W. Collins, late Engineer-in-Chief of the United States Revenue Cutter Service, died recently at Amityville, Long Island, at the age of sixty-four years. He served under Commodore Farragut at the storming of Fort Fisher, and was on the *Kearsarge* at the time of the fight with the *Alabama.*

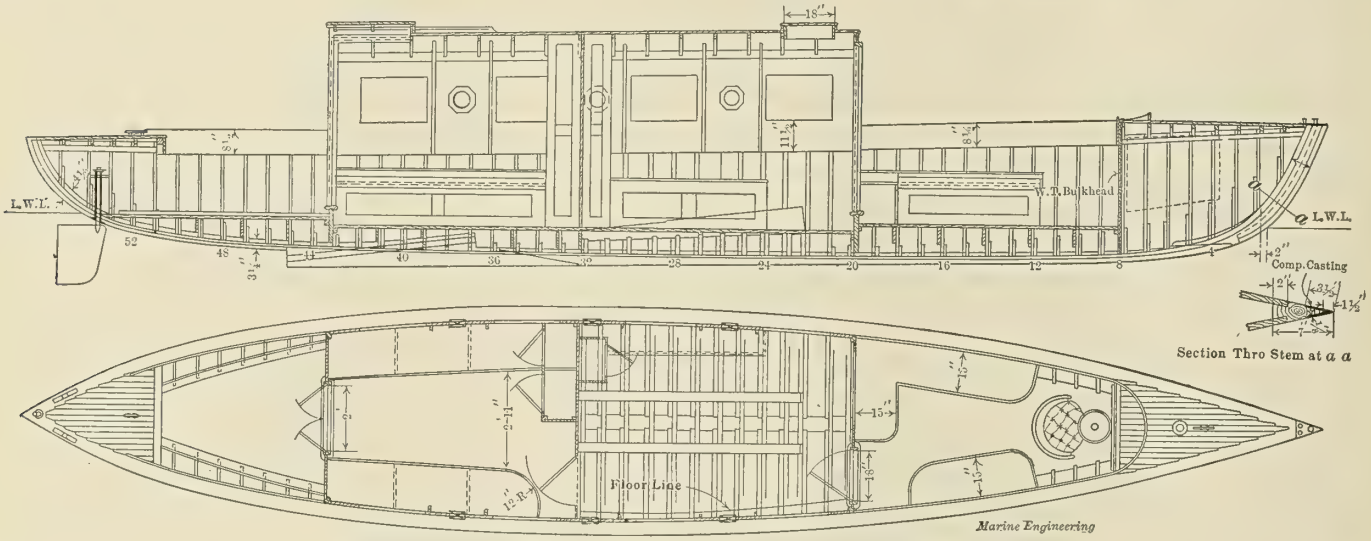
Andrew G. Wilson, manager of the Marine Department of the Maryland Steel Company, at Sparrow's Point, recently died very suddenly at his home in Wilmington, Del. His seven years of service with the Maryland Steel Company were preceded by thirty-six years with the Harlan & Hollingsworth Company.



OUTBOARD PROFILE AND ACCOMMODATION PLAN OF 35-FOOT LAUNCH.

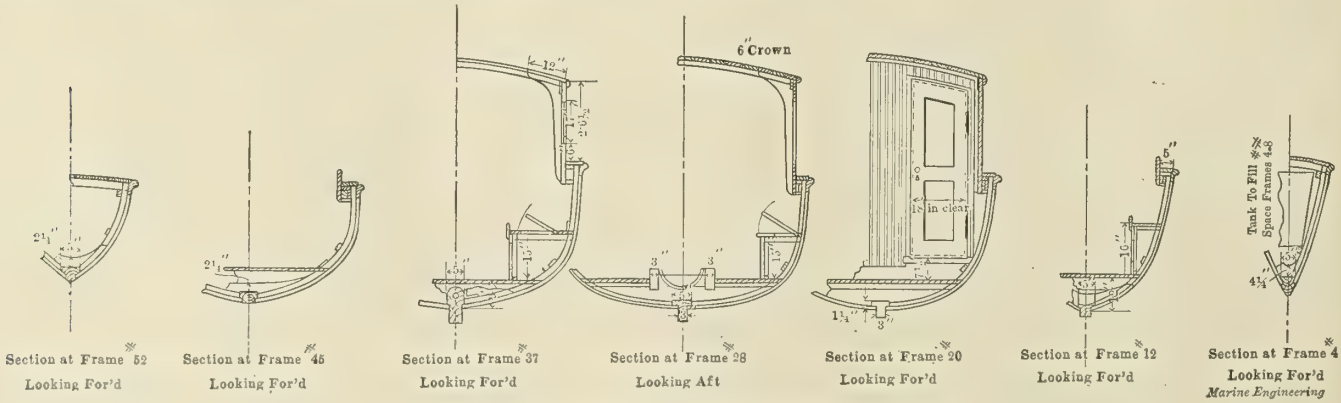
A HALF-CABIN FERRY LAUNCH.

We are enabled to present drawings of a 35-foot launch designed by Messrs. Hoyt and Clark of 17 Battery Place, New York, for use in the sheltered bays along the northern coast of Long Island, as a ferry for going back and forth from house to business. This boat has a length over all of 38 feet 7 inches; length on water line of 35 feet; a water line beam of 6 feet, which becomes 6 feet 9 inches extreme; and has a draft of 1 foot to the base line and 18 inches to the bottom of the keel. The lines as shown in the illustration are drawn to the outside of the planking. A rather unusual feature in this boat is the provision of a forward cockpit, enabling the owner to be out where he can see what is going on ahead, without the necessity of being shut up in the pilot house.



INBOARD PROFILE AND ARRANGEMENT PLAN, SHOWING ENGINE FOUNDATION.

The keel and keelson are of white oak connected with ½-inch galvanized iron bolts, the keel being rabbetted for the reception of planking. Stem and stern pieces are respectively of hackmatack and white oak, sided 5 inches, scarfed for planking, and riveted to keel and keelson. The stem is capped with composition casting.


6" Crown
Tank To Fill Space Frames 4-8
Section at Frame 52 Looking For'd
Section at Frame 45 Looking For'd
Section at Frame 37 Looking For'd
Section at Frame 28 Looking Aft
Section at Frame 20 Looking For'd
Section at Frame 12 Looking For'd
Section at Frame 4 Looking For'd
Marine Engineering

CROSS SECTIONS OF LAUNCH AT VARIOUS POSITIONS ALONG LENGTH.

The frames are 1 by 1¼ inches, and of white oak. In way of engine space, however, they are 1½ by 1¼ inches. All are mortised into the keelson and slightly rounded on the inside. They are spaced 8 inches apart throughout. The floors are scored over keelson, and have a minimum depth above top of keelson of 4¼ inches. In the engine space they have a thickness of 1¾ inches. The bilge clamp is of yellow pine, measuring 4 by 1¼ inches amidships and tapered to the width of 2½ inches at the ends. The shelving, of the same material, is 3 by 1 inches and the mahogany covering board measures 5 by 1 inches.

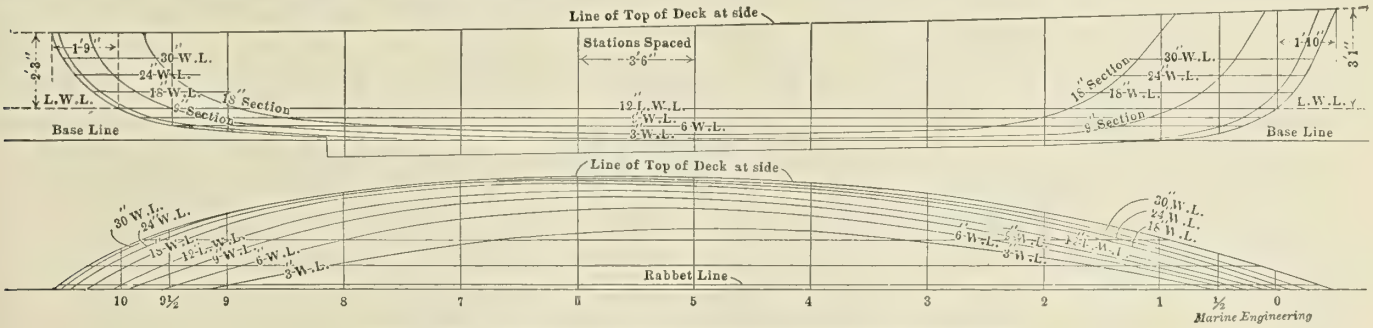
The planking is of white cedar about ¾ inch thick and riveted to frames. The sheer strake is of white oak; coaming in cockpits is of mahogany 8½ inches deep and ⅝ inch thick; the sides of the cabin are ⅞ inch thick, of Honduras mahogany, and measure 2 feet 6½ inches high. Beams of the house top are of oak, 1 inch by 1½ inches spaced 12 inches on centers, with 6-inch crown, and fitted at the ends into a 3½ by ⅝ inch mahogany strip. The top of the house is of white pine ⅝ by 4 inches, covered with 15-ounce duck laid in thick lead and glue, and bound by a 1½-inch mahogany half-round strip.

A watertight bulkhead is fitted at frame 8, at the after end of the forward cover deck, the after side of which has a mahogany finish. The bulkhead at the forward end of the cabin is also of mahogany, ⅝ inch thick; that at the after end of engine space and that at the after end of the cabin are of the same thickness and material. The deck house is fitted with eight fired glass fixed lights on the sides, measuring 17 by 24 inches, and one at the forward end, measuring 30 by 18 inches. There are also six air ports fitted in the sides, with inside measurement of 6 inches.

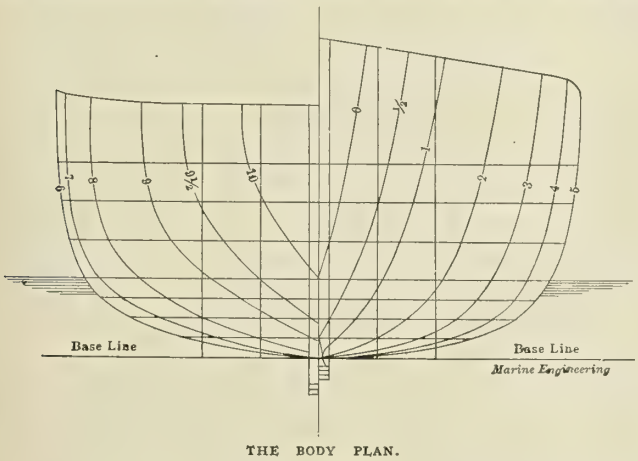
The rudder stock is 1½ inches in diameter and is made of bronze and fitted with quadrant. The rudder port is of brass pipe supported at the top. The rudder consists of ½-inch bronze plate and will be supported at the foot by a bronze casting connected with the propeller shaft strut. The steering gear is operated by a powerful wheel of automobile pattern, situated in the forward cockpit, while a vertical lever in the engine space gives a second point of control. Bronze wire tiller ropes leading through sheaves and fairleads are fitted. The gasoline tank is of copper and practically fills the space under the forward deck. The canopy top over the forward cockpit is carried on polished brass stanchions in brass sockets, and has a framing of galvanized iron pipe with cover of heavy duck. A screen of glass, fitted in mahogany frame at the forward end of the cockpit and measuring 24 by 24 inches, swings back and stows under the canopy top when not needed.

It is desired to have power which shall at all times provide for a speed of twelve miles per hour, and the designers expect to get between thirteen and fourteen miles on trial. The engine, the pattern of which is not yet fixed, will be of about 25 horsepower, with four cylinders and of the four cycle type.

Contract for construction of the hull has been placed with The Fraser Hollow Spar and Boat Company, Greenport, N. Y.



WATER LINES, AND BOW AND BUTTOCK LINES OF HALF-CABIN FERRY LAUNCH.



THE BODY PLAN.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of February 10, 1906, the following percentage of completion of vessels building for the United States Navy:

			Jan. 1.	Feb. 1.
BATTLESHIPS.				
Virginia	19 knots.	Newport News Co.	98.	98 6
Nebraska	19 "	Moran Brothers Co.	84.24	86.17
Georgia	19 "	Bath Iron Works.	91.24	93.35
New Jersey	19 "	Fore River Shipbuilding Co.	95.5	96.5
Rhode Island	19 "	Fore River Shipbuilding Co.	99.	99.5
Connecticut	18 "	Navy Yard, New York, N. Y.	93.69	95.16
Louisiana	18 "	Newport News Co.	94.17	95.24
Vermont	18 "	Fore River Shipbuilding Co.	70.7	73.5
Kansas	18 "	New York Shipbuilding Co.	69 8	72.5
Minnesota	18 "	Newport News Co.	80.33	82.08
Mississippi	17 "	Wm. Cramp & Sons.	47.32	49.08
Idaho	17 "	Wm. Cramp & Sons.	45.39	47.19
New Hampshire	18 "	New York Shipbuilding Co.	33 4	37.1
ARMORED CRUISERS.				
California	22 knots.	Union Iron Works.	87.5	88.7
South Dakota	22 "	Union Iron Works.	86.2	87.3
Tennessee	22 "	Wm. Cramp & Sons.	91.66	94.53
Washington	22 "	New York Shipbuilding Co.	91.9	94.4
North Carolina	22 "	Newport News Co.	30.74	34.48
Montana	22 "	Newport News Co.	25.84	30.11
SEMI-ARMORED CRUISERS.				
St. Louis	22 knots.	Neafie & Levy Co.	86.	88.34
Milwaukee	22 "	Union Iron Works.	87.9	89.8
SCOUT CRUISERS.				
Chester	24 knots.	Bath Iron Works.	15.53	18.87
Birmingham	24 "	Fore River Shipbuilding Co.	18.2	21.
Salem	24 "	Fore River Shipbuilding Co.	17.6	21.1
SUBMARINE TORPEDO BOATS.				
Submarine No. 9		Fore River Shipbuilding Co.	46.9	51.
" " 10		Fore River Shipbuilding Co.	37.8	43.3
" " 11		Fore River Shipbuilding Co.	39.9	43.5
" " 12		Fore River Shipbuilding Co.	38.7	43.1

Forced draft was first used for marine purposes on the Hudson River steamers prior to the Civil War. In 1882 it was introduced into the English Navy, and still later was applied in the merchant service.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands, in New York, not later than the 10th of the month, to insure the carrying out of such instructions in the issue of the month following.

The edition of the March issue of Marine Engineering *comprises 6,500 copies. We have no free list, accept no return copies and issue only enough to supply the regular demand, so that the 6,500 copies represent legitimate circulation.*

NOTICE.

Marine Engineering is printed by a firm which is fighting the printers' strike. That strike is not yet over; but matters are getting into better shape every week, and no delays are anticipated.

The American Ship.

"Why should senators waste time over the question whether the Gallinger bill for the restoration of the American ship to its old place on the ocean is a subsidy or a bounty, or a measure analogous to the land reclamation act, or what not?

Open the way for the American flag to its proper place at the front of the world's carrying trade, and call it a subsidy, or by any other name.

Redeem our one great national failure, and call the redemption fee a bounty if you will.

Rehabilitate the American merchant marine, and compare the process to the land reclamation legislation, or to anything else in sight.

The people are not afraid of the word 'subsidy,' or of any other word that may be used to describe the method of assuring that restoration and revival which President Roosevelt had in view when he said to Congress:

'To the spread of our trade in peace and the defence of our flag in war a great and prosperous merchant marine is indispensable. We should have ships of our own and seamen of our own to convey our goods to neutral markets, and in case of need to re-enforce our battle line.'

Let us have them. Let the lack of them no longer disgrace this nation."—New York *Sun*.

We heartily second the motion.

The Metric System.

At present writing there seems to be a more or less concerted movement looking toward making compulsory the use of the metric system in all branches of the government service, and making it the only legal standard in commercial work. One of the leading metropolitan papers has been pushing the campaign with much vigor, but with very little appreciation of the real difficulties surrounding the situation. It seems to have been assumed that the mere enactment of a law such as is called for would be quite sufficient to start the thing in motion, and push it along immediately to a successful conclusion. It is a fact, however, that in the engineering profession, which is the one profession above all others making the greatest use of measurements of all sorts, the introduction of a new system would call for a vast amount of expenditure, and create untold confusion. It has been estimated by one of the officers of the Westinghouse Electric & Manufacturing Company that the replacement of the tools, dies, jigs, etc., in their shops by similar implements conforming to the requirements of the metric system would cost no less than three hundred thousand dollars; while if the change were to include their drawings, this figure would be nearly doubled. With such an expense as this in a single establishment, it is quite apparent that the cost to the manufacturing interests of the country could be placed with entire conservatism at not less than one hundred million dollars.

There is, of course, an extremely logical relation as among the various units—linear, volumetric and gravimetric—in the metric system, and on this account it is widely heralded as affording most excellent facilities for computation. This would be true if it were necessary to reduce from volume to weight or vice versa of simply a given quantity of pure water, which is the material used as the connecting link between the two. Unfortunately, however, it is occasionally necessary to measure iron or steel or some other material not at all like water, and this necessitates at once the introduction of a constant reduction factor covering the weight per cubic meter of said substances. It is readily seen that such a computation is not a particle more simple than would be a computation based on feet and pounds, by making use of the weight per cubic foot of the substance in question. Hence, the alleged greater simplicity of the metric system, while theoretically most beautiful in conception, is practically more or less of a fiction.

For the naval architect and marine engineer little advantage would be obtained by the change, because not only would the requirement have to be met of measuring iron and steel, but the very water entering into the computations of a marine man is in most cases sea water, which has a density greater by about three percent than that of pure water, and hence would require an introduction of a constant multiplier, which is no improvement over the present method of computation.

Engineers in the Navy.

"We have now no engineering corps, though we used to have the best in the world."—Melville.

"The United States government requires that a merchant ship of 3,400 horsepower shall carry no less than three licensed engineers; while it may be assumed, from what we know of the matter, that *not a man connected with the engineering force on the Bennington would have been able to obtain a license.*"

Both of these quotations are taken from the September number of Marine Engineering. The latter of the two has been made the basis of an attack in the current number of the *Proceedings of the United States Naval Institute*, in which it is characterized as a "wild statement which can only have emanated from ignorance or malice." If it is a question of ignorance as to how the navy can be expected to get on without proper complement of engineer officers, we immediately plead guilty to the charge. If, on the other hand, malice consists in an attempt to correct the set of circumstances which made possible the terrible disaster to the *Bennington*, and the system to which that set of circumstances could trace its origin, we again plead guilty.

The article above mentioned contains within itself a proof of the assertion which we made in italics in the editorial quoted. It has never been claimed that any one on that ill-fated ship, aside from the ensign, who was in responsible charge of her machinery at the time of the accident, was in any way qualified to take charge of that machinery. It, therefore, remains only to show that this officer would have been unable under the laws governing the United States Steamboat Inspection Service to have obtained a license permitting him to exercise the authority and assume the responsibility which were his at that time. The article includes a number of appendices, in one of which is a "Statement of Additional Requirements Necessary to Secure United States Merchant Engineer Licenses," which reads in part as follows:

"No person shall receive an original license as an engineer or assistant engineer****who has not served at least three years in the engineers' department of a steam vessel; ****provided that **** any person graduated as a mechanical engineer from a duly recognized school of technology may be licensed to serve as an engineer of steam vessels after having had not less than one year's experience in the engineer department of steam vessels. **** Any person having had a first assistant engineer's license for two years, and having had two years' experience as second assistant engineer, shall be eligible for examination for chief engineer's license." It is again stated that in the examinations the examination itself has a weight of only ten percent, the general qualifications of the candidate, such as experience, etc., having a weight of ninety percent. Taking these quotations from the appendix to the article, and viewing them in connection with the fact that the ensign had not been out of the Academy a sufficient length of time to have obtained the experience required by law for a merchant marine engineer's license, it is quite evident that the statement in our September number was neither "wild" nor unjustified, but was absolutely in accordance with the facts of the case as they have come to hand. Be it understood that this is nothing against the ensign himself; but it is distinctly against the perpetration of a system which could place an unqualified and inexperienced officer in a position of such responsibility.

We have argued all along, not for a return to the old engineer corps, but for the adoption of some system embodying in a large measure the common sense which is so conspicuously absent from the way things are now handled, and we have not hesitated to refer to the method of handling ships in the merchant marine, and the excellent success obtained by that method. We fully realize that conditions in the merchant marine are widely different from those in the navy, and that the system in detail, successfully in vogue in the one, would not necessarily be a success in the other. It does, however, afford a splendid basis for observation of methods which are successful, and many of which could be readily adopted in the navy without prejudice of any sort.

A part of the argument in the article under discussion is very pertinent. We wish to quote as follows:

"It was most certainly never contemplated that a young ensign or midshipman should be placed in a position of full responsibility in any one branch, as was the case with the chief engineer of the *Bennington*.**** Up to the time of the disaster the spirit to inspire a movement towards steam engineering was almost entirely lacking, and **** the time and attention given to steam engineering was sadly below that given to the other branches.**** The chief engineer of the *Bennington* was a young ensign, recently graduated with a sound groundwork of engineering knowledge, but of insufficient years to enable him to fully appreciate the responsibilities and duties of his position. In the days of the engineering corps no such position was ever held by an assistant engineer of the same lack of experience."

In this connection we can but repeat the suggestion made editorially in our issue for January: "Make all officers engineers first, and line officers afterwards." The modern warship is simply a floating box of machinery of varying degrees of delicacy, but of immense quantity and very considerable complexity. The proper handling of this maze of machinery requires engineering skill of the highest order, and it is fast coming to be recognized that engineering is the only profession really required on board such a vessel. Both theoretical knowledge and experience are necessary. The Naval Academy can provide the one, but not the other.

The need is very urgent. Until we have an adequate engineering force—adequate in point of skill and experience as well as numbers—we cannot consider that our navy has any sort of general efficiency of which we have a right to be proud.

"Every officer on a modern war vessel must be an engineer, whether he wants to or not." Roosevelt.

ABSTRACT FROM LLOYD'S REGISTER FOR YACHTS.

EDITION OF 1905-1906.

ARRANGED BY HARRISON S. TAFT.

1. Measurements for Scantling Numbers.

1. Length. L. Distance in feet between the points on the outside of the stem and stern post or counter which are .15 of the rule depth below top of beams at said points on center line.

2. Breadth. B. Maximum molded beam.

3. Depth. D. Distance in feet at middle of length (L) from top of a bar or a flat plate keel to top of upper deck beams at center line, assuming a round up of 1-4″ per foot of beam.

4. Girth. G. Distance in feet at middle of length (L) measured along the molded edge of the frame bar, from center line to top of beams at side of ship.

5. Bilge Diagonal. N.

Distance in feet at middle of length (L) from top of upper deck beam at center line to molded edge of frame, as measured on a diagonal drawn from said point on upper deck to the intersection of the horizontal base line and the vertical half-breadth line.

6. Transverse Number.

$TN = \frac{1}{2}B + D + G + 2N.$

7. Longitudinal Number.

L/D not over 7: $LN = L \times TN.$

L/D over 7: $LN = (L \times TN)\left(\frac{L}{10D} + .3\right)$

8. Equipment Number.

$E = (L \times TN)$ + twice the product of the length and height in feet of any erections that may be fitted above the upper deck.

9. Scantlings under transverse number; frames; reverse frames; floor plates; bulkhead plating.

10. Scantling under longitudinal number; bar keels; stems; stern posts; shell plating throughout; deck stringers; tie plates; all fore and aft keelson and stringer angles; center keelsons; wood deckings; rudders; members of double bottoms; riveting of butts, etc.

11. Size of beams is regulated by the length of beams amidships.

2. Scarphs.

Scarphs of bar keels, stems and stern posts are to be in length not less than nine times the thickness given by tables for a bar keel.

3. Stems.

Stems may be gradually reduced from full size at the heel to ¾ of their full sectional area at the head.

4. Stern Frames.

1. The stern frames may be gradually reduced from full size at the counter to the head, where their dimensions can be the same as required at the head of the stem.

2. The part of the stern frame forming the lower part of the propeller aperture is to have its greater dimension horizontal.

3. The heel, forming part of the keel, is to extend with a fair taper forward of the post for a distance equal to at least five times the rule depth of the keel where there is no propeller aperture, but not less than eight times said depth where there is an aperture.

4. Stern frames cast in one piece are to be let fall on hard ground after being raised through an angle of 45°.

5. Stern frames cast in more than one piece, rudders, steering quadrants and tillers are to be dropped on hard ground from a height of from 7 to 10 feet; then to be strung up and well hammered with a sledge of not less than 7 pounds.

TABLE I.—TYPE OF CENTER LINE KEELSON ON TOP OF FLOORS.

Type of Keelson.	Vessels Fitted with Bar Keels.		[a] Vessels with Flat Plate Keels Fitted with an Intercostal Plate Keelson.
	Bar Keels Only.	[a] With an Intercostal Plate Keelson Between Floors.	
	Longitudinal Numbers.		
D A	Under 5,800	Under 13,800	Under 7,900
D A + B P	5,800 " 13,800	13,800 " 35,000	7,900 " 25,800
K P + T A	13,800 " 25,800	35,000 and over.	25,800 " 35,000
K P + T A + R P	25,800 and over.	.....	35,000 and over.

D A = double angles. B P "= bulb" plate. K P = vertical keelson plate. T A = top angles. R P = rider plate. + means "with a."

[a] Intercostal plates to have double clips to floors and to a flat plate keel.

5. Center-Line Keelsons.

1. A center-line keelson must be fitted when the half breadth on top of floors is 2 feet or over.

2. Said center keelsons are to extend as far forward and aft as possible, and are to maintain their midship scantling for 1-2 length amidships.

3. In vessels with fine ends deep floor plates are preferable to extending the center keelson to the extreme ends of the ship. Butts of said keelsons are to be kept clear of all keel and garboard butts; those of the rider plates being kept clear of those of the center keelson and its angles.

6. Frames.

1. All frames are to extend from the keel to the gunwale.

2. When the transverse number is 68 or over, before and abaft the 3-5 vessel's length amidships, the thickness of the frames may be reduced 1-20 inch if the depth forward and aft of said 3-5 length, from top of floors to top of beams is less than amidships.

3. The frames of the aft counter are to be of the same scantling as the main frames.

4. Heel pieces, when fitted to butts of frames, are to have three rivets in each flange on each side of the butts. They are to extend for 3-5 length amidships.

5. When ballast is carried between the floors the frames are to be worked double to above the height of the ballast, the doubling pieces being of the same size as the frame bars themselves.

6. In way of double bottoms the horizontal and vertical flanges of the frames can be of the same width.

7. Double frame angles are to be worked at all watertight bulkheads.

7. Floor Plates.

1. A floor plate is to be fitted to every frame. They are to maintain their midship scantling for 1-2 length amidships.

2. According to the depth they are to be worked straight on top or curved up the bilge in a fair curve to twice their center-line depth.

3. In the engine space the floors are to be 1-20 inch thicker than midship floors, those in the boiler space being 2-20 inch thicker.

4. Bulkhead floor plates are to be deep enough to admit of riveting the bulkhead plating to said floors above the reverse frames. They are to be in all cases of the same weight as the midship floors.

5. In deep, narrow-keel vessels the floor plates are to be of sufficient depth to securely fasten said parts of the vessel together.

6. Water courses are to be provided so as to efficiently drain the ship.

7. In vessels of great power the after floor plates are to extend well above the screw shaft, holes being cut in said floors for said shaft.

8. Floor plates not made in one piece should have their butts located alternate on opposite sides of the middle line.

9. Transom Floor. A deep floor plate is to be fitted in way of the stern post and fastened to same by double angles. Said floor plate shall be at least of the same weight as midship floors.

8. Reverse Frames.

1. A reverse frame is to be fitted to the top edge of all floor plates.

2. They are to extend up the frames to the top edge of the side stringer or cabin-sole stringer angle bar alternately, when the transverse number is 36 and under 48; to top of said cabin stringer angle bar and to four feet above same alternately when said number is 48 and under 72; to top of said cabin stringer angle bar and to the upper deck alternately when said number is 72 and above. In the way of any deck erections and of all large deck houses, all the reverse frames are to extend to the upper deck, or partial bulkheads be fitted.

3. The reverse frames can be reduced 1-20 inch in thickness before and abaft the 3-5 length amidships when the transverse number is 100 or over and the depth from top of floors to top of beams is less than said depth amidships.

4. The reverse frames are to be worked double wherever ballast is carried on top of floors. They are also to be worked double throughout the engine and boiler spaces extending from bilge to bilge. In the engine space they are to be 1-20 inch, in the boiler space 2-20 inch thicker than amidships.

5. Angle butt straps at all butts are to be of sufficient length so as to take three rivets on each side of the butts.

6. In way of double bottoms the horizontal and vertical flanges of the reverse frames can be of the same width.

9. Floor, Bilge and Side Keelsons.

1. A Floor Keelson consisting of double angles riveted back-to-back with intercostal plates, secured to the shell, is to be fitted on top of floors on each side of the center when the half breadth at level of top of floors is 8 feet or above.

2. A Bilge Keelson is to be fitted when the midship girth from center line at top of floors to top of beams at sides exceeds 12 feet, and no floor keelson or side stringer is called for.

3. A Side Stringer is to be fitted wherever the frame girth amidships, or at any other part of the vessel, from top of floors to top of beams at side, or where said girth from the cabin stringer to the upper deck beams at sides exceeds 8 feet.

TABLE 2.—TYPE OF SIDE STRINGERS.

Longitudinal number....	Under 4,900.....	4,900 under 40,000.....	40,000 and above.
Type of stringers.....	Single angles..	Double angles.....	Double angles chocked to shell.

4. When the frames are stayed to the cabin beams the side stringers may be dispensed with.

5. The floor and bilge keelson and the side stringers are to extend to the extreme ends of the ship and are to maintain their midship scantling for 1-2 length amidships. The bilge keelson and side stringers are to be attached to breast hooks.

10. Keelson Clips.

1. Short angle clips are to be fitted on all frames and top of floors in way of the center, floor and bilge keelsons and side stringers, except where intercostal plates are fitted.

11. Deck Beams. Beam Knees.

1. Beams are to be fitted to alternate frames with a stanchion at the center line or near thereto. When alternate reverse frames extend to the upper deck the beams should be located on the frames having reverse frames. Beams are to maintain their midship scantling for 3-4 length amidships, with a reduction before and abaft said 3-4 length.

2. When the girth from top of floors to top of upper deck beams at sides is 12 feet or above, a tier of cabin sole beams is to be fitted. When said girth from top of floors to top of cabin beams is 12 feet or more a tier of orlop beams is to be fitted.

3. Half beams, where used, are to be fitted to alternate frames, having a double lug attachment to the fore and aft carlings or coamings.

4. Under windlasses or deck houses and at the ends of all large deck openings the beams are to be of increased size or else extra stanchions provided. Strong beams are to be fitted in the machinery space. Angle beams are to be fitted to every frame in the way of watertight flats. In the way of masts in sailing or auxiliary yachts the beams are to be worked at every frame or otherwise strengthened.

5. When it is necessary to dispense with a cabin or orlop beam, web frames, deep framing or otherwise is to be fitted.

TABLE 3.—SIZE AND NUMBER OF RIVETS FOR BEAM KNEES.

Length of Beam Amidships.	8 under 9	9 under 10	10 under 11	11 under 12	12 under 13	13 under 14	14 under 15	15 under 16	16 under 17	17 under 18	18 under 19	19 under 20	20 under 21	21 under 22	22 under 23	23 under 24	24 under 26	26 under 28	28 under 30	30 under 32	32 under 34	34 under 36
Depth of beam knee. Inches.....	8	8½	9	9½	10	10½	11	11½	12	12½	13	13½	14	14½	15	15½	16	17	18	19	20	21
Number of rivets in knee.....	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5
Diameter of rivets.....	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	1

Beam knees are to measure across their throat not less than $\frac{6}{10}$ of their depth.

12. Deck Stringers and Tie Plates.

1. The upper deck stringer plates are to maintain their midship scantling for 1-2 length amidships.

2. When the frames extend through an upper deck stringer plate the gunwale bars are to be worked intercostally between said frames, with an auxiliary gunwale bar of equal scantling worked continuously on the inside of the frames, being riveted to the stringer plate.

3. Stringer plates are to be fitted to the cabin deck beams, having the intercostal shell clips and the continuous face angle as for an upper deck stringer, as stated in paragraph 2.

4. The cabin deck stringer may have lightening holes cut in same between the beams, provided said holes do not exceed 1-3 the stringer's breadth in width, and the length or the combined length does not exceed 1-3 the beams' spacing.

5. The butts of all deck stringers and angles are to have at least a two-frame space shift from each other and from the butts of their adjacent shell strakes.

6. Tie plates, equal to the weight of the stringer plates, are to be worked on each side of all deck openings —extending all fore and aft—with diagonal tie plates in addition in way of the masts on sailing or auxiliary yachts.

7. In way of large deck openings the tie plates are to be of increased width, or the deck plated over in way of said openings. An angle bar is to be worked connecting the tie plates to the fore-and-aft carlings or coaming plates.

8. Mast Partners are to be of the same thickness as the stringer plates and be in breadth at least three times the diameter of the mast hole. An angle bar or bulb angle is to be fitted so as to allow for wedging.

13. Stanchions.

Stanchions should have solid welded heads and heels, with at least a two-rivet connection at each end.

They should be fitted vertically over each other under every beam. When for any reason they are omitted, a girder should be worked so as to efficiently support the deck beams. Additional stanchions should be fitted under the windlass, deck houses, and at ends of large deck openings.

14. Bulkheads.

1. A watertight bulkhead is to be fitted forward extending to the upper deck, in all steel yachts 100 feet or more in length.

2. A watertight bulkhead is to be located at both ends of the machinery space, extending to the upper deck, in all steel yachts of 50 but under 100 feet in length. The space around the stern tube should be enclosed in a watertight compartment in yachts of this size. When of 100 but under 280 feet in length, four watertight bulkheads are to be fitted (three when the length is 100 but under 220 and the machinery is located aft) extending to the upper deck.

3. The bulkhead plating is to have a double angle bar attachment to the shell, deck and inner bottom plating.

4. The vertical stiffeners are to be of reverse frame size, spaced not further apart than the frame spacing. When the depth from the top of the cabin beams to top of keel or inner bottom is 8 feet or above, said vertical stiffeners are to equal the scantling of the frames. The lower ends of all vertical stiffeners are to extend down to the frames (being well riveted to the floor plates), or be secured to the inner bottom plating by bracket plates. When the depth of a bulkhead exceeds its breadth the stiffeners are to be worked horizontally. A plate of the same scantling as the tie plates is to be fastened to the bulkhead in way of the cabin sole stringer for supporting the ends of the deck planking.

5. When doors are fitted in a watertight bulkhead they are to be so arranged that they can be worked from the upper deck.

6. The watertightness of the end collision bulkheads is to be tested by filling the end peaks with water to the height of the load waterline.

15. Shell Plating.

1. The shell plating is to maintain its midship weight for 1-2 length amidships.

2. In single-screw vessels those plates which are attached to the propeller post are to be of midship weight; the boss plates being 2 pounds heavier than the midship plates of the same strake.

3. The weight of the sheerstrake may be less than otherwise if the weight of the strake or strakes below said sheerstrake and that of the upper deck stringer are correspondingly increased.

4. Frame liners in way of the outside strakes are to be of the same width as the frame angle flange and be worked in one length. Bulkhead liners are to be one frame space in breadth.

5. Butts of adjoining strakes of the shell plating are to have a shift of at least two frame spaces; those of alternate strakes at least a one-frame space shift.

6. Butts of the garboards are to be kept clear of the keel scarphs and are to be at least two frame spaces clear of each other on opposite sides of the vessel.

TABLE 4.—BREADTH OF SHELL PLATE STRAKES.

Rule depth. Feet.....	8 under 10	10 under 12	12 under 14	14 under 16	16 under 18	18 under 20	20 under 22
Maximum breadth, Inches,..	38	40	42	44	46	48	50

In order to comply with riveting table.

16. Riveting.

TABLE 5.—DIAMETERS OF RIVET HOLES.

Diameter of rivet. Inches.....	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$
Diameter of rivet hole. Inches.....	$\frac{5}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{11}{16}$	$\frac{13}{16}$	$\frac{15}{16}$	$1\frac{1}{16}$	$1\frac{1}{16}$	$1\frac{3}{16}$

1. The thicker of two plates is to regulate the diameter of the rivet used in securing them together.

2. All double and treble riveting, and all butts of the shell plating are to be chain fashion, except for the keel, stem and stern post, which are to be zigzag riveted.

3. Butt laps are to have complete rows of rivets.

4. With single butt straps alternate rivets may be omitted in the third row of a treble-riveted butt strap joint.

5. Edge strips for flush shell plating are to be worked continuously; their thickness being not less than that of the plates they connect.

6. Countersinks are to extend entirely through the thickness of the plate or angle bar.

7. All rivet holes are to be punched from the faying surfaces opposite each other in the adjoining parts, laps, lining pieces, butt straps and frames.

8. Rivet holes are not to be punched in frames at the turn of the bilge or where the curvature is great until after the frames have been bent to the required shape.

9. All work to be carefully closed up with nuts and screw bolts before the riveting is begun.

10. The following to be single riveted:

(*a*) Butts and edges of bulkhead plating.

(*b*) Butts and seams of inner bottom plating (outside of machinery space) except middle line and margin strakes.

(*c*) Seams of deck plating.

11. The following to be double riveted:

(*a*) Butts of deck tie plates and deck plating.

(*b*) Middle line and margin strakes of inner bottom plating. Also all butts of said plating in the machinery space.

12. The following to be treble riveted:

(*a*) Butts of the center line girder plates of double-bottom vessels.

(*b*) Butts of the center line keelson.

(*c*) Butts of all rider plates.

(*d*) Butts of floor plates not made in one piece.

(*e*) Angle staps fitted to keel, keelson and stringer angle bar butts.

TABLE 6.—RIVETING SCHEDULE.

Longitudinal Number.	Butts of						Rivets in Bar Keels, Stems, Stern Posts and Rudders.	
	Keel Plate.	Garboard Strakes and Strake Next Below the Sheer Strakes.	Shell Plating between the Garboard Strakes and the Strake Next Below the Sheer Strakes.	Sheer Strakes and Upper Deck Stringer Plate.	Cabin Sole Stringer Plate.	Edges of the Shell Plating Fore and Aft.	Diameter. Inches.	Spacing. Inches.
1,200 under 2,200	D R T	S R T	S R T	D R—$\frac{1}{6}$ L	S R T	S R T	$\frac{5}{8}$	$3\frac{1}{4}$
2,200 " 3,000	D R T	S R T	S R T	D R—$\frac{1}{6}$ L	S R T	S R T	$\frac{11}{16}$	$3\frac{3}{4}$
3,000 " 4,100	D R T	D R—$\frac{1}{6}$ L	S R T	D R—$\frac{1}{6}$ L	S R T	S R T	$\frac{11}{16}$	$3\frac{3}{4}$
4,100 " 4,900	D R T	D R—$\frac{1}{6}$ L	S R T	D R—$\frac{1}{6}$ L	S R T	S R T	$\frac{11}{16}$	$4\frac{1}{8}$
4,900 " 6,800	D R T	D R—$\frac{1}{6}$ L	D R—$\frac{1}{6}$ L	D R T	S R T	S R T	$\frac{11}{16}$	$4\frac{1}{8}$
6,800 " 10,500	T R—$\frac{1}{6}$ L	D R T	D R—$\frac{1}{6}$ L	D R T	S R T	S R T	$\frac{11}{16}$	$4\frac{1}{8}$
10,500 " 17,500	T R—$\frac{1}{6}$ L	D R T	D R T	D R T	S R T	S R T	1	5
17,500 " 25,800	T R—$\frac{1}{6}$ L	D R T	D R T	T R—$\frac{1}{6}$ L	D R T	S R T	1	5
25,800 " 32,600	T R—$\frac{1}{6}$ L	D R T	D R T	T R—$\frac{1}{6}$ L	D R T	D R T	1	5
32,600 " 40,000	T R T	T R—$\frac{1}{6}$ L	D R T	T R—$\frac{1}{6}$ L	D R T	D R T	1	5
40,000 " 45,300	T R T	T R—$\frac{1}{6}$ L	D R T	T R—$\frac{1}{6}$ L	D R T	D R T	$1\frac{1}{8}$	$5\frac{1}{8}$
45,300 " 48,100	T R T	T R—$\frac{1}{6}$ L	T R—$\frac{1}{6}$ L	T R—$\frac{1}{6}$ L	D R T	D R T	$1\frac{1}{8}$	$5\frac{1}{8}$

S R T = single riveted throughout. D R T = double riveted throughout. T R T = treble riveted throughout.
D R — $\frac{1}{6}$ L = double riveted for $\frac{1}{6}$ length amidships. T R — $\frac{1}{6}$ L = treble riveted for $\frac{1}{6}$ length amidships.
When double riveting is called for $\frac{1}{6}$ length amidships single riveting is to be used at ends.
When treble riveting is called for $\frac{1}{6}$ length amidships double riveting is to be used at ends.

17. Double Bottoms.

1. When a side bar keel is fitted the center line vertical keelson plate is to extend down to the bottom of the keel with a side plate riveted on each side, so that the combined thickness of the three plates shall equal that required for a bar keel.

2. The center line keelson is to have a double angle bar connection to the inner bottom plating.

3. Solid manhole floor plates are to be fitted to every frame. They are to be built in one length from the center line keelson to the margin plate.

4. An intercostal side longitudinal clipped to floors, shell and inner bottom plating is to be fitted on each side, midway between the center line keelson and the margin plates, extending all fore and aft, where the half breadth of the inner bottom is 8 feet or over. Additional intercostal girders are to be fitted in the engine space.

5. When the inner bottom is discontinued the regular keelsons should lap over into the double bottom space for at least three frame spaces, and be connected to the longitudinal girders of said space; or else other means should be provided for maintaining continuity of strength.

6. Solid frame brackets are to be fitted outside of the margin plates to every frame, with the reverse frames fitted to their upper edge.

7. As far as possible angle clips are to be worked opposite to each other, on each side of a plate.

8. Throughout the engine and boiler spaces the floor plates, and frame brackets on the outside of the margin plates, are to have a double clip connection to their respective girder. Otherwise, a single clip connection may be used.

9. The reverse frames and all vertical angle clips in the boiler space are to be 1-20 inch thicker than otherwise.

10. Manholes are to be cut in the side girders, floor plates, and inner bottom plating so as to allow of free access to the double bottom space, the edges of said manholes being made smooth. No manhole is to be cut in the center line vertical keelson.

11. There shall be five 3-4 inch rivets in each flange of the vertical clips forming the connection between the floor plates and brackets to the margin plates.

12. There shall be a well, one frame space wide, in the aftermost part of the engine room when a double bottom is worked throughout the boiler and engine space.

13. Means should be provided for a free flow of air from one division to another, either by cutting the liners short or making holes in the floor plates as high up as possible.

14. Double bottoms are to be tested for watertightness by a head of water at least equal to the deep load draft of the ship.

18. Valves: Cement, Etc.

1. No sluice valve or cock is to be fitted to the collision bulkhead. When fitted to other watertight bulkheads they must be arranged to work from above the waterline.

2. All head and stern pumps are to be provided with sea cocks fitted next to the shell plating.

3. Soil pipes which are attached to the shell plating below the waterline are to have the lower lengths of steel or iron extending some distance above the waterline. If the remaining parts of said pipes be of lead they must be properly protected externally with either zinc or iron.

4. A sounding pipe is to be fitted on each side to all hold and ballast tanks, with a doubling plate under same.

5. The total area of the perforations in bilge suction pipe strainers should be double that of the cross section of said pipes.

6. The frames and plating of the bottom of all vessels should be efficiently covered with some approved cement.

19. Rudders.

1. The main piece or stock of a rudder frame is to have a straight taper from below the top pintle to the heel. In double plated rudders the stays or arms are to be fitted opposite to the pintles.

2. The main piece or stock of single plated rudders which have their arms keyed to said stock should have a groove on its after side, equal in depth to the thickness of the rudder plate.

3. The arms of single plated rudders are to be placed alternately on opposite sides of the rudder plate.

4. The diameter of the rudder head in steam yachts is to be not less than that given by the formula:

$$d = .12\sqrt[3]{A \times D \times (20 + S)^2}$$

where d = diameter of rudder stock in inches.

A = total area of rudder abaft center of stock, in square feet.

D = distance in feet of center of gravity of area A abaft the center of the rudder stock.

S = speed of vessel in knots.

20. General Notes.

1. In sailing and auxiliary yachts the framing in way of each mast should be efficiently strengthened according to the rig of the vessel.

2. Pine decks are to be laid with their grain vertical. Teak decks may be 1-6 less in thickness than required for other kinds of wood.

TABLE 7.—RENEWAL OF CHAIN CABLES WHEN WORN.

Original Size of Chain Cable. Inches.	To be Renewed When Worn to	Original Size of Chain Cable. Inches.	To be Renewed When Worn to	Original Size of Chain Cable. Inches.	To be Renewed When Worn to
1 1/16	29/32	1 1/8	1	1 9/16	1 13/32
1 1/8	1	1 3/16	1 1/16	1 5/8	1 1/2
1 3/16	1 1/32	1 1/4	1 1/8	1 11/16	1 17/32
1 1/4	1 1/16	1 5/16	1 3/16	1 3/4	1 9/16
1 5/16	1 3/32	1 3/8	1 7/32	1 13/16	1 5/8
1 3/8	1 1/8	1 7/16	1 9/32	1 7/8	1 11/16
1 7/16	1 5/32	1 1/2	1 11/32	1 15/16	1 23/32

21. Rivet Spacing. Lloyd's Yacht Register.

	Dias.
1. In edge riveting, center to center of rows	1½
2. In butts of plating, center to center of rows	2
3. In butts of outside plating, stringers, center keelsons, and floor plates	3½
4. In butts and edges of inner bottom plating	4
5. In edges of outside plating (forward and aft) and bulkhead plating; butts of bulkhead plating; upper deck stringer angles	4½
6. In bulkhead frames when caulked; keel angles; bar keels	5
7. In frames; reverse frames; floors; keelson; beams; and bulkhead stiffeners	7

8. Shell clips to stringers and intercostal plates. 4 rivets in each flange.

9. No rivet is to be nearer the edge of a plate or of an angle bar than its own diameter.

The United States Civil Service Commission announces examination on March 14 for the position of marine fireman at $540 per annum and rations. Applicants should apply to the Commission in Washington for form 1093.

The United States Civil Service Commission announces examination March 21 and 22 for vacancies in the position of topographic draftsman in the Postoffice Department at $900 per annum. Applicants should apply for form 1312.

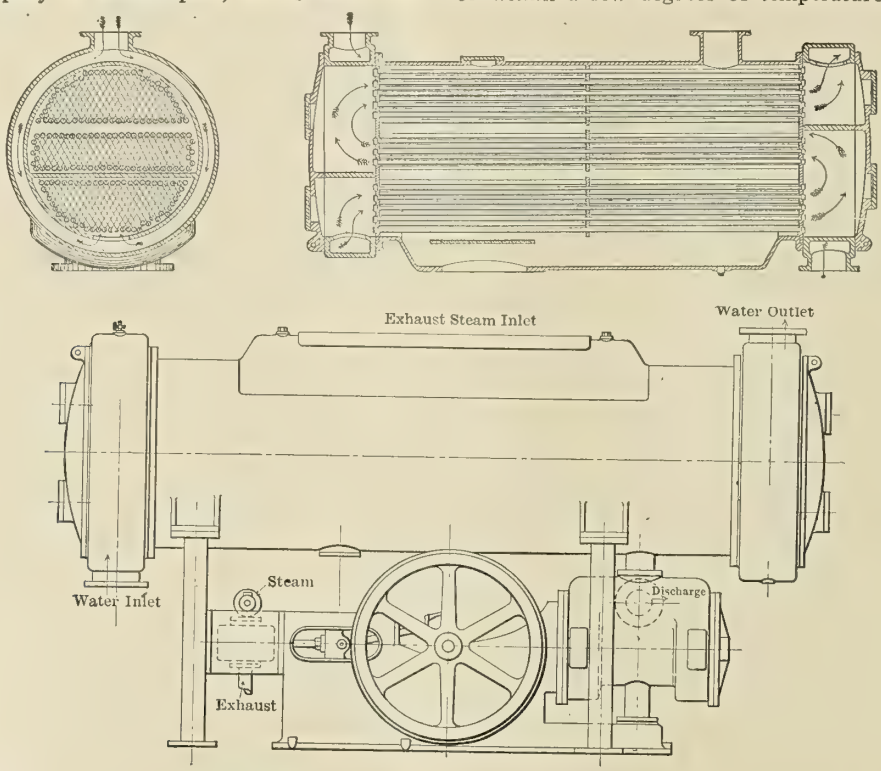
TABLE 8.—LLOYD'S YACHT REGISTER. WIDTH OF BUTT LAPS AND BUTT STRAPS. SPACING OF RIVETS.

Weight of Plate. Lbs.		Diametral Pitch.	4	6	8	10	12	14 to 18	20 to 26	28 and 30
Diameter of Rivet. Inches.			5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
Width of:	Single riveted butt lap	..	1 1/2	1 3/4	2	2 1/4	2 1/2	..	..	..
	Double " " "	..	2 1/2	2 1/4	3	3 1/2	4 1/2	5	6	..
	Treble " " "	..	..	..	..	5 1/2	6 1/4	7 1/4	9	10 1/2
	Single " " strap	..	2 1/2	3	3 1/2	4	4 1/2	..	..	..
	Double " " "	..	4 1/4	5	5 3/4	6 1/2	8	9 1/4	11 1/2	..
	Treble " " "	..	..	..	..	..	..	14 1/4	16 3/4	19
	Single " seam lap	..	1 1/4	1 1/8	1 3/4	2	2 1/4	2 1/2	3	..
	Double " " "	..	..	..	..	3	3 1/2	4 1/2	5 1/2	6
	Single " edge strip	..	..	..	..	..	..	..	..	..
	Double " " "	..	..	..	..	..	..	..	..	..
Spacing of rivets.	1.—Edge riveting. Center to center of rows	1 1/8	7/8	1 1/8	1 1/8	1 3/8	1 5/16	1 1/8	1 5/16	1 1/8
	2.—Butts of plating. " " " " "	2	1 1/8	1 3/4	1 1/8	1	1 1/4	1 1/8	1 3/4	2
	3.—Butts of shell plating, stringers, center keelsons and floor plates	4 and 3 1/2	1 1/4	1 1/8	1 3/4	2	2 1/4	2 1/8	3 1/8	3 1/4
	4.—Butts and edges of inner bottom plating	4	1 1/4	1 1/8	1 3/4	2	2 1/4	3	3 1/8	4
	5.—Longitudinal seams of the shell plating forward and aft: seams and butts of bulkhead plating: upper deck stringer angles	4 1/2	1 3/8	1 5/8	2	2 1/4	2 3/4	3 3/8	4	4 1/2
	6.—Bulkhead frame bars when caulked: keel angles: bar keels	5	1 1/8	1 7/8	2 1/8	2 1/8	3 1/8	3 3/4	4 3/8	5
	7.—Frames: reverse frames: floors: keelsons: beams. bulkhead stiffeners	7	2 1/4	2 5/8	3	3 1/2	4 1/2	5 1/4	6 1/4	7
Number of rivets per row in edges of shell plating between frames amidships, not including frame rivets.	Maximum spacing	4 1/2	1 3/8	1 5/8	2	2 1/4	2 3/4	3 3/8	4	4 1/2
	Frame spacing. 15 inches	..	11	9	8	6	5	..	..	..
	" " 16 "	..	12	10	8	7	5	..	..	..
	" " 17 "	..	..	10	9	7	6	..	..	..
	" " 18 "	..	..	11	9	7	6	5	..	..
	" " 19 "	..	..	..	10	8	6	5	..	..
	" " 20 "	..	..	..	..	8	7	5	..	..
	" " 21 "	..	..	..	..	..	7	6	5	..
	" " 22 "	..	..	..	..	..	7	6	5	5
	" " 23 "	..	..	..	..	..	..	6	5	5
	" " 24 "	..	..	..	..	..	..	7	6	5

ENGINEERING SPECIALTIES.

Improved Condenser Apparatus.

This surface condenser, designed for maintaining a high vacuum, has been placed upon the market by the C. H. Wheeler Condenser & Pump Company of Philadelphia, and is fitted with a Mullan crank and fly wheel suction valveless air pump. The condenser is of the series parallel type, in which the steam enters the top group of tubes, passes by means of one header into the middle group, and thence through the other header into the lower section and finally out. With this arrangement, the hottest steam comes into contact with surfaces cooled by the coldest water, and in turn permits of the condensed steam or feed water being discharged from the air pump at the highest temperature possible, or within a few degrees of temperature corresponding with the tension of steam due to the vacuum in the condenser. The construction of the water chamber provides for the water's entering at the bottom of the condenser and discharging at the top of the



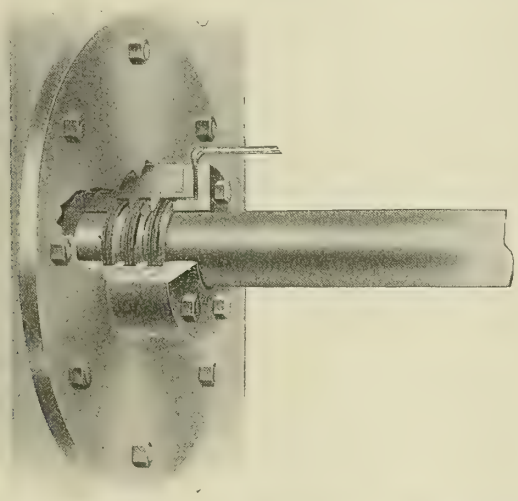
opposite chamber, this arrangement keeping the condenser filled with cooling water at all times.

The air cylinder of the air pump has a central port uncovered by the piston at each end of the stroke, but otherwise covered. The discharge valves are of the usual spring-seated poppet type, located at both ends of the cylinder. In shop tests these pumps have been operated within one-half inch of the barometric reading, and within two inches of absolute vacuum under full load operation, which provides means for insuring the best results with the modern steam turbine. The pumps are built either horizontal or vertical, to suit the needs of each particular case.

One of these sets was recently installed on the ferryboat *Edgewater* in New York harbor, displacing an ordinary surface condenser mounted with the old type of combined air and circulating pump. The old equipment had been in use about three years and gave a vacuum ranging under different conditions from 18 to 24 inches of mercury. The new equipment is said to have furnished a vacuum of from 27 to 28½ inches, with a corresponding reduction in fuel consumption of nearly 40 percent.

Metallic Packings.

It is seldom that a patent or invention reaches its highest point of efficiency while in the hands of the inventor. In other words, history would seem to demonstrate that a basic patent acts as a drag to progress until it has expired. An illustration of this is shown by the progress made with the Corliss valve gear since it has come into competitive manufacture. A very striking instance of this kind is shown in the manufacture of metal piston-rod packing. This was for years in the hands of people who were satisfied to manufacture in a small way, charging an exorbitant price for their product, and seeming to depend more upon chance than on knowledge for their success. A party of mechanical engineers and users of metal packing, having conceived the idea of making it on mechanical



principles, soon discovered that this product was peculiarly amenable to ordinary common sense. This success brought them to the attention of the Garlock Packing Company, Palmyra, N. Y., who at once arranged to take control of the product.

The demands of marine service seem to have received very careful consideration from these people. The style of metal packing heretofore used on marine work has been very difficult to place on bottom rods of vertical engines, and many an engineer has been tempted to "say things" when the entire contents of the stuffing box fell into the bilges just when the job was all done. This danger is said to be entirely obviated in their marine type, as is also the excessive and irregular wear of rod caused by other types with heavy band springs. These packings are made with split case, and can be applied or removed at any time without disturbing any part of the engine; arrangements are made for drainage of water, and the packing is guaranteed to withstand any water shock that can be safely put on the engine. There is no babbitt metal, fibrous or similar substance used, and the whole appears to be a mechanical problem worked out to its logical finality.

TECHNICAL PUBLICATIONS.

Electric Wiring, Diagrams and Switchboards. By Newton Harrison, E. E. Size 5 by 7½ inches. Pages 272; figures 105. New York, 1906. Norman W. Henley Publishing Company. Price $1.50.

A thoroughly practical treatise covering the subject of electric wiring in all its branches, the book includes explanations of diagrams which are thoroughly explicit, and take care of everyday problems, with methods of obtaining the best results. The work is very simply written, requiring no greater knowledge of mathematics than that included in arithmetic, and the entire theory worked out simply from a statement of Ohm's law, covering the resistance of a circuit. The fundamental principle of drop of potential in circuits is shown, and circuits covering complete house wiring connections in examples are clearly illustrated. A few facts concerning testing are included, together with some information about lighting and conduit work. The book appears to be a very handy and comprehensive volume, and well fitted for the needs of the lineman, foreman and contractor.

Die Schiffsschraube. By Albert Achenbach, Marine Engineer in the Royal Technical High School at Kiel. Size 6½ by 9½ inches. Pages 84; plates 25. 1906, Kiel. Robert Cordes, Publisher. Price 10 marks.

This, the first of three sections of the work, covers the development and graphical representation of screws for ships, and gives a good insight into the conditions governing the development of the form of the blades on the drawing board. The first chapter, which is prefaced by a bibliogaphy, covers the geometrical theory of the subject, and is followed by chapters showing respectively the chronological development of screw propellers; the construction of pitch triangles for propeller blades; the measurement of pitch and determination of mean pitch; the representation of blades of propellers in both projected and developed forms; the preparation of drawings for screws, and special forms of propellers.

The work, which is in German, is of very comprehensive character, and of course covers propellers of both uniform and variable pitch, the variation being both radial and from the leading to the following edge of the blades. In some places the calculus is used in the development of the theory, although in general dependence is placed upon trigonometry alone. The plates are all separate from the text, and are so fitted that they may be entirely opened up outside the text for ready reference back and forth. The work gives evidence of being a very valuable one, and we look forward with considerable anticipation to the other two sections.

Machine Shop Arithmetic. Fourth Edition. By F. H. Colvin and W. L. Cheney. Size 4 by 5¾ inches. Pages 144; figures 9. New York, 1905. The Derry-Collard Company. Price 50 cents.

The continued demand for a simple presentation of the problems coming before the man in the shop has made it necessary to issue a fourth edition of this work, which fact is in itself a good indication of the favor which it has met. The problems are presented in a clear and concise manner, and the book contains besides a number of tables of prime importance in the machine shop. Additions to previous numbers which appear for the first time in this edition include tables of metric threads and of force, shrink and running fits.

The Senate on February 14 passed the Ship Subsidy bill by a vote of 38 to 27. The House comes next.

QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the Editor in this column. All communications must bear the name and address of the writer.

Q. 329.—Would you please tell me in your Queries how to line up a beam engine. W. M. F.

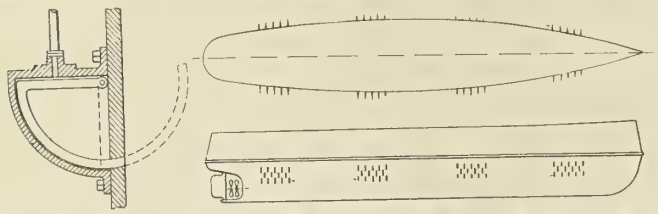
A.— Run a line through center of cylinder to top of slides. Try the slides with gauges thwartship, and with straight edges, and if they are not too far out of line they can be brought to position by screwing up on the brace nuts. The beam should be brought to a horizontal position, and the cylinder end placed exactly in the center between the slides. Then run a line down from the fork end of connecting rod journals on the other end of beam, so that it will pass through the center of the space between the cranks at the shafts. This line should then be sighted with the line in the cylinder. If they are in one plane the beam is straight fore and aft; if not, it must be swung straight by shifting its pillow blocks. Next move the beam up and down so that the crosshead (with the jaws and gibs off) travels between the slides. Take the distance between the end of the crosshead and slides, in top and bottom positions. If this distance varies in the two positions, the beam pillow blocks are not level, and the low brass must be lined up.

Next swing the connecting rod, and, if it is hung properly, travel it with the cranks. If the distance between the face of cranks and side rod on each quarter of a circle is the same, the shafts are in line with the beam. The cheek pieces should be removed from the eye of the drag crank during this operation, in order to leave the crank pin perfectly free. Care should first be taken to ascertain whether the two shafts are in line. This is done by noting the position of the crank pin in the eye of the drag crank in successive crank positions of travel.

SELECTED MARINE PATENTS.

805,688. MEANS FOR STOPPING THE MOTION OF VESSELS. EUGENE P. A. VILLETTE, LILLE, FRANCE.

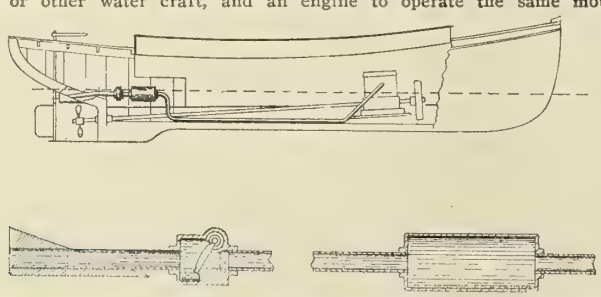
Claim.—1. In apparatus for quickly stopping vessels in movement, plates consisting of two sections telescoping into each other when at rest and



arranged vertically in zigzag form and in group along the length of the hull of the vessel; the inner section having projections and the outer one stops to limit the movement of the interior one; and the outer plates having projections adapted to abut against the wall of the hull for the same purpose. Two claims.

806,083. MUFFLER FOR INTERNAL-COMBUSTION ENGINES. FRED J. GOWING, SACKET HARBOR, N. Y., ASSIGNOR OF ONE-HALF TO JEROME B. ROSEBOOM, SACKET HARBOR, N. Y.

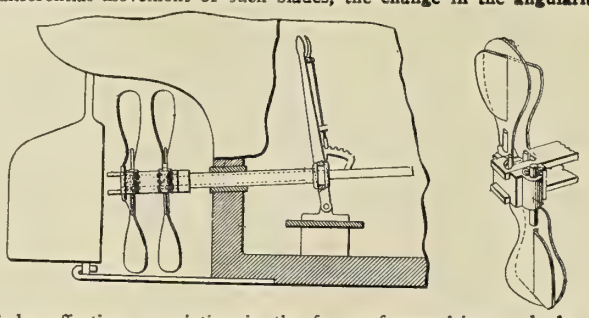
Claim.—1. In a muffler of the class described, the combination with a boat or other water craft, and an engine to operate the same mounted



thereon, of a pipe adapted at one end to receive the exhaust from said engine, a drum or like part connected with said exhaust pipe, an extension pipe, a check valve connected with said extension pipe, and a nozzle adapted to discharge the exhaust from said engine beneath the surface of the water. Five claims.

807,498. SPEED-CONTROLLING REVERSING-PROPELLER. CHARLES F. ROPER, HOPEDALE, MASS.

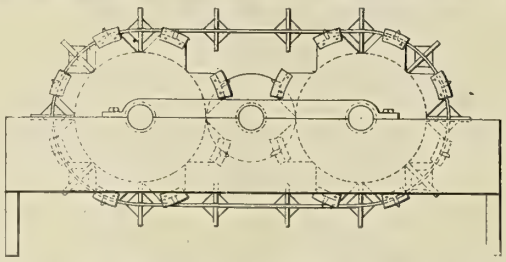
Claim.—1. A shaft adapted to be rotated in one direction at a substantially uniform speed, a propeller mounted thereon, comprising two sets of angularly-movable blades, and means to vary the angularity of the blades of the sets and to vary the relative angularity of the blades of the two sets by a differential movement of such blades, the change in the angularity of



the blades effecting a variation in the force of propulsion, and also serving to reverse the direction thereof, while the differential movement causes the blades to maintain a substantially constant resistance on the motor. Ten claims.

805,871. PROPELLER. FRANCIS W. McCAIN, MIDWAY, W. VA.

Claim.—1. In a propeller for vessels, the combination with flexible metal bands and means to drive the same, of paddles having at the ends



slots at the median line through which the bands extend, straps extending around the ends of the paddles and fastened to the bands, and braces between the straps and bands. Two claims.

Lloyd's Register of British and Foreign Shipping has issued a summary of shipbuilding for the year 1905, the figures being given in much detail. Without going into extensive particulars, we will state simply that the merchant shipping launched in the United Kingdom consisted of 795 ships of an aggregate of 1,623,168 gross tons, which is practically 100,000 tons greater than in the previous record year of 1901. The figures include vessels of over 100 tons only.

In France the tonnage launched was 73,124; in Germany, 255,423; in Italy, 61,629; in Holland, 44,135; in Norway, 52,580. These figures compare with a total of 302,827 tons in the United States, represented by 200 vessels of upwards of 100 tons, 60 percent of the tonnage having been on the Great Lakes.

The total launchings outside of Great Britain amounted during the year to 781 vessels of above 100 tons each, with an aggregate of 891,754 gross tons. This makes the world's shipbuilding during the year 1,576 vessels amounting to 2,514,922 gross tons. In addition to this there were 118 warships launched, of an aggregate of 363,211 tons displacement.

The Bureau of Navigation reports that there were constructed in the United States during the month of January, 61 sail and steam vessels of an aggregate of 11,729 tons. To this magnificent total the Great Lakes contributed one ship, *Frank C. Ball*, of 6,909 tons, or more than half the aggregate tonnage. It will be seen that the remaining ships have an average size of 80.3 tons. Of the total, only three ships were of steel, the two on the coast aggregating less than 400 tons, or an average of less than 200 tons each.

The Bureau of Navigation reports that during the six months ending December 31, 1905, there were constructed in the United States 542 vessels of a total of 136,097 gross tons, this making a total for the year of 1,054 vessels of 306,563 tons. In the six months covered the construction of steel steamers amounted to 51 vessels of 100,127 tons, of which 21 vessels aggregating 80,932 tons were accounted for by construction on the Great Lakes. The average size of all the vessels included in the total for the six months figures out at 251 tons. The steam vessels built of steel averaged 1,961 tons, while the ships on the Great Lakes included under the latter heading averaged 3,853 tons.